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ABSTRACT

This report describes the research setting for the Schools, Computers, and Learning Project, an ongoing longitudinal and multidimensional study of the mutual adaptation of classroom practice and computer technology. Following a brief discussion of the research intentions and an overview of the research methodology, the report is divided into five sections: (1) the research project (team, focus, methodology, and agendas in the language arts, social and environmental studies, music and the special needs student, mathematics, and a computational perspective on schooling); (2) the school as a project site (demography, programs, physical layout, and computer facilities and resources); (3) the school and the community (the neighborhood and the parent group); (4) the school and the board of education (board resources, policies, and computer initiatives); and (5) a detailed portrait of "Hampton" public school (grade by grade descriptions of K-6 teachers and classes as well as special teachers and administrators). It is noted that the school described here is the first of a group of regional pilot test centers, each of which will have a different focus; and the report is based on data gathered as the computers were being installed and as patterns of use were emerging, and is intended to serve as a foundation for subsequent reports on the evolution of computer use in the classroom. Seven tables, 13 figures, and references are provided. (CGD)

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SCHOOLS, COMPUTERS, AND LEARNING PROJECT

Interim Report #1 From the Kingston Regional Pilot Test Centre: A Description of the Research Setting

Education and Technology Series

Project Co-ordinator
DONALEEN HAWES

Principal Investigators
WILLIAM EGNATOFF
WILLIAM HIGGINSON
LARRY MILLER
JOHN OLSON
RENA UPITIS

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Chris Ward, Minister
Bernard J. Shapiro, Deputy Minister

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Abstract

This report is a description of the research setting for the Schools, Computers, and Learning Project. The research project, involving a large team of researchers, school support personnel, and staff of the project school, is longitudinal and multidimensional. The research team is collectively studying the mutual adaptation of schooling and technology that occurs when a computer rich environment is established. In addition to global questions, a wide range of curricular, developmental, organizational, and social concerns are being examined.

Dr. Larry Miller is investigating the effects on writing and reading of using computer programs for the language arts, and is interested in helping teachers bridge the gap between their teaching practice and their espoused theories of how children learn to read and write. Dr. John Olson is interested in the use of computers in the integration of social and environmental studies units and in the impact of computers upon teacher routines. Dr. Rena Upitis is examining music exploration and opportunities for developing forms of self expression and communication through music with severely handicapped children. Dr. William Higginson is studying the learning of mathematics as mediated by computers. The first phase of his research is a case study of mathematics learning using the ICON with available software. Dr. William Egnatoff is using notions from computer science to analyse classroom routines and to explore how computational experience influences the way children and teachers think about those routines.

The project is based in an average-size school with just over 200 pupils and ten full time and four half time teaching staff, one teaching assistant, and a secretary. It is an experienced staff - only one teacher has taught less than 5 years and the rest range in experience from 14 to 25 years.

The report briefly describes the programs offered by each classroom teacher and by the specialists in French, music, enrichment, and remediation.

The computer facilities and resources, established to create a computer-rich environment, comprise 27 networked ICON computers, 10 printers and 2 LEXICON fileservers. The teachers have chosen to put ten ICONs in a computer centre and have distributed the rest throughout the school, having one, two, or three in their individual classrooms.

The school is rich in human as well as technical resources. The project provides a full time computer resource teacher and a half-time technical person. The support team also includes 12 parent volunteers and a half-time high school co-operative student.

The school regularly receives all software distributed by the Ontario Educational Software Service (OESS) of the ministry and is a test site for ministry funded software produced by the University of Toronto Computer System Research Institute.

A description of the neighbourhood as well as the parents' group is provided to give a sense of the school in relation to the community. The parents are very active and supportive of the school and the project. The neighbourhood now includes two multiple dwelling rental housing units in addition to older well-established suburban homes. Most pupils in the school are of similiar racial and ethnic backgrounds but of varying socio-economic status.

The board policies, resources, and computer initiatives are described to provide a larger context for the interpretation of classroom practices.

The final section of the report provides profiles of the staff and portrayals of dynamics of each classroom. The aim is to provide enough detail to give the reader a sense of this particular school, which is necessary to put in perspective the context of the research.

Each of the five principal investigators will prepare separate reports at the end of the school year based on data collected to address the research questions they have set for the initial phase of the study. The second collective report will document the evolution of computer use during the first year of the project. Individual and collective reports will follow at the end of each year giving readers timely access to the findings. In this way documentation is provided on an ongoing basis rather than at the end of the project.

Preface

This document is intended to serve as a foundation for a number of specialized reports which will emanate from the Schools, Computers, and Learning Project over the next few years. The researchers on the project team come from a broad range of disciplinary and experiential backgrounds. Nevertheless they share a number of fundamental assumptions. One is that computers are powerful and versatile machines which have already shaped our culture in significant ways and which have the potential to be a major force in education in the future. A second shared view is that the issues raised by the introduction of technology into school classrooms are, in many cases, variations on classical questions about the nature, purpose, and methods of education. As such they deserve deep and thorough consideration.

Accordingly, in the reports which follow, the researchers will describe and interpret the experience of children and teachers in school classrooms in terms of issues of significance for education in the information age. It is hoped that these documents will be useful to a broad range of parents, educators, researchers, educational administrators, and policymakers.

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Introduction

The Schools, Computers, and Learning Project is a collaborative venture involving the Ontario Ministry of Education, the Frontenac County Board of Education and the Faculty of Education of Queen's University at Kingston. The primary purpose of the project is to examine the mutual adaptation of classroom practice and computer technology. The board selected an elementary school as the project site. Five members of the faculty of education developed a longitudinal research program which involves both observation of ongoing activity and close collaboration with the teachers at the selected school. The ministry is providing the funds for equipment, support, and research. The site is the first of a family of Regional Pilot Test Centres of the Ministry of Education, each with a different focus.

This report is a brief description of the research intentions and an extensive description of the research site: the staff and students, the programs offered, the facilities, the neighbourhood, the position of the school within the school board, the teachers' philosophies and approaches, and the classroom dynamics.

The report is based on data gathered as the computers were being installed and as patterns of use were emerging. Findings on the evolution of computer use will be provided in subsequent reports.

RESEARCH PROJECT

The first section of the report is an outline of the objectives of the research project, the intentions of the research team, the composition of the research team, and the research methodology. Both the research issues of collective interest and the research agendas of individual team members are presented.

Research Team

The research team of the faculty of education consists of five principal investigators (Drs. William Egnatoff, William Higginson, Larry Miller, John Olson, and Rena Upitis), a half- time Project Coordinator (Dr. Donaleen Hawes), and five part time research assistants, one working with each principal investigator.

The school support team for the project consists of a full-time computer resource teacher (Gaye Beckwith), a half-time computer technician (Pat Dudley), and a part-time high school co-operative student enrolled in a computer technology program.

The Schools, Computers, and Learning Project is built upon previous work by the research team. In part, it is an outgrowth of three earlier studies funded by the Ministry of Education (Carmichael, Burnett, Higginson, Moore, and Pollard, 1985; Olson and Eaton, 1986; and Upitis, 1987).

The project has the following characteristics:

1. it is long-term (up to six years);
2. it is based in an entire school;
3. it offers curricular and technical support for the teachers;
4. it is based on participant observation;
5. it makes use of ministry-funded software and of hardware meeting ministry functional specifications;
6. the project team is in direct contact with software developers and researchers and teachers involved with similiar projects;
7. there will be frequent and current dissemination of findings.

Research Focus

The project deals with the mutual adaptation of new information technology and education in the context of a computer-rich environment, consistent with the plans of Ontario school boards for the next five to ten years. The research team will study computers as a means to develop better teaching and learning strategies. The researchers are interested in the match between computer use and styles of learning, teaching, and school administration. Creating such a match involves two sorts of adaptations.

In looking at the adaptation of the computer to the school, the research team is attempting to understand how computers might become readily accessible and widely used in every part of the school and across the entire curriculum.

In looking at the adaptation of the school to the computer, the research team is examining to what extent and in what ways the nature of schooling will change as computers become a normal and integral part of school life.

The study follows earlier research which suggests further exploration of the relationship between computers and

- peer tutoring and learning through social interaction;
- students' control over their learning;
- fundamental developments in mathematics, science, and the arts;
- professional research and writing tools;
- new ways of managing the classroom in light of the increased freedom that the computer affords;
- the presence of volunteers in the classroom and the sense of a school community.

Some teachers may wish to use the computer for doing more efficiently what they already do, but in another way; others may wish to make changes in their teaching and in the curriculum to take advantage of the capabilities of the computer. While respecting existing ideas that teachers have about computers, the research team encourages the teachers to develop ways for their pupils to use the computer as a tool for personal expression through language, music, art, and explorations in mathematics and science.

Methodology

The research methodology used in the project involves standard field research techniques such as document analysis, interviews, and participant observation. The project involves three different approaches:

1. Documenting effective classroom practices: Videotape records of computer-based learning, observation, interviews, samples of students' work, and teacher planning documents are being used to probe student and teacher perceptions of the social and cognitive processes associated with computer-based learning and to test theories of computer-based learning.
2. Studying innovation by intervention: The data indicate how the people involved in the process interact and what external forces are perceived to influence the course of events. The insights gained from analysis of this data support the on-going activity of the project and may lead to a better understanding of what helps innovative systems work well.
3. Attending to curricular problems: The project team is interested in the role of new information technology in the effective learning of various subjects in the school curriculum. The researchers, as specialists in the different curriculum areas, will work with teachers to look at persistent problems in the teaching of those subjects at the elementary level and at how computer-based learning might help alleviate some of these problems.

The research team meets for several hours each week to discuss the research agenda, the collection and analysis of data, and emerging research questions. The computer resource teacher gives a weekly report on events which have occurred at the school. He provides an update on his involvement, including his in-service activities, and reports on the use of computers by students, teachers, and administrators.

A project office has been established at Queen's Faculty of Education with facilities where visitors can come for meetings, for studying project data and reports, for viewing videotapes of classroom activities, for reviewing software on the ICON, or for making arrangements for visiting the project site. There is also a meeting room at the school. Opportunities for visitors to view the computer centre can be arranged.

Research Agendas

Responsibility for studying global questions concerning the school setting (resources, school climate, community involvement) and the mutual adaptation of school and computers is shared by all members of the research team. Dr. Donaleen Hawes coordinates this research and is responsible for the collective reports. The global questions frame the particular investigations, spanning a wide range of curricular, developmental, organizational, and social concerns, to be carried out by the individual members of the research team. The questions and methods evolve as the teachers in the study identify aspects of their work which they would like to understand more fully.

Descriptions of the principal investigators' individual research questions appear in the following subsections. A description of the objectives and role of the computer resource teacher is also provided because of his extensive involvement in the development and implementation of the project.

In-School Support and Direction

Gaye Beckwith, the computer resource teacher, was seconded for two years from the board for this project in order to act as an in-school resource person and a liaison between the ministry and the board and between the board and the faculty.

(1) Involvement: The computer resource teacher has been involved in all stages of the development of this project. Prior to being seconded from the board for the project he served as consultant for six years in the areas of science, mathematics, and most recently, instructional computers. As consultant he developed resources and manuals for teachers and offered in-service workshops. His role in this project is to provide in-service training for the teachers and students at the project school and to provide direction for the use of computers. He learned about computers through self-directed exploration and by completing several computer courses. Mr. Beckwith has been most useful when working with teachers because he can remember what it was like overcoming the anxieties of facing new technology.

The computer resource teacher has been part of the team since the inception of the project. His experiences as a computer consultant, and as an active member of the Regional Computer Advisory Commitee and of the Plan of Action for Computers in Elementary Schools Committee (PACES) have reinforced his view of the need for leadership in the area of computers in education. He believes that the era of computer literacy is over and that the advantages of a computer-rich environment need to be demonstrated.

He views the computer as the most powerful tool we have for allowing students to achieve success with higher-order learning. The computer with its interactive, responsive nature is a new medium through which students explore their thoughts and talents. If accepted, it will assist the educational system in developing the individual potential of students rather than teaching them "en masse". Mr. Beckwith believes that the expense of computers is justified if we look beyond the acquisition of basic skills to the need for higher-order learning.

(2) Objectives: The computer resource teacher's in-school support work will change over the course of the project, but the objectives will continue to focus on teacher/student support and providing direction. These objectives are:

1. To install the computer facilities at the project site and to provide in service to all teachers.
2. To encourage teachers to gain knowledge in a specific area and to share this expertise with others so that each teacher will have his or her own area of strength upon which the rest of the staff can rely. As a consultant, he learned that teachers must be involved in the process of innovation and must be allowed to develop expertise according to their needs and interests.
3. To take an active role in working with students. Usually this form of work is in conjuction with the teacher. To date he has worked on special projects with different classes, such as a project newspaper, a data base for babies born in 1986, and Logo. Each of these teachers will hopefully share this expertise with the rest of the staff, and students will provide leadership to other students: together they are building a network of expertise. Mr. Beckwith intends his role to become obsolete as teachers gain the necessary expertise to become independent computer users.
4. To encourage the creative use of the computer. Teachers and students have responded favourably to the introduction of creative software. Currently, IPAINT, Draw, Logo, Micro news, the data base, and word processors dominate use in both structured and free exploration time. Software which encourages self-expression will continue to be the focus of his in-service.

Computers and Language Arts

Larry Miller has four major research interests focusing on computers and language arts. They are:

1. The long-term investigation into writing with computers.
2. The study of a group of children, and their use of computers, as they progress through three grades.
3. The transfer of learning.
4. The exemplary use of software.

(1) Writing and computers: The topic of children using computers as a composing tool is a familiar one in recent literature. Although there has been a great deal of speculation about the impact of word processors on children's writing, there is little research, especially of a longitudinal nature. Long-term investigations are important because computers appear to have a novelty effect, and extended study may offer a more realistic portrayal of their value.

The few studies that have been reported agree on one seemingly salutary effect of word processors on children's writing. Students tend to compose longer stories when using the computer than when writing with pen or pencil. Whether or not children write better stories with word processors has not been established. Word processing programs offer the potential for fostering revising and editing skills, but whether or not this feature is used fully will be influenced by the teacher. As well, publication, the final stage of the writing process, can be facilitated by word processing programs, but again, the use of this feature is dependent on the teacher.

During the initial stage of the Schools, Computers, and Learning Project it became clear that the manner in which teachers use the features available on word processors to foster the writing process was part of an even larger issue: whether or not teachers involved in the project use a process approach in fostering composition in general. Indeed, even though the investigation was in an embryonic stage, it became clear that a teacher's underlying notion of

how composing skills should be developed is a powerful determinant of the computer's role in the child's development as a writer. Thus, if teachers do not see children as capable of such composing skills as revising and editing, the computer functions, even though readily available, may not be used.

A researcher may have preconceived notions of how computers should be used in fostering the composing process, but this school was selected for study because a large majority of staff had not used computers previously as an integral aspect of their teaching. Thus, the first research focus was modified to take into account the manner in which teachers might change their notions about teaching the writing process as well as the role of new technology in fostering this change.

(2) Children's computer use over time: Observations of North American and European teachers who use computers in the language arts suggest that paradoxically, the types of programs used on the computer often contrast with the teacher's normal style of instruction. For example, many teachers were observed using drill and practice computer programs, but these exercises were almost non-existent elsewhere in the day. If teachers did not find computer programs and uses that were congruent with their style of teaching, they would eventually stop using the computer or relegate it to a minor role in instruction. Indeed, informal observations of elementary school classrooms indicate that while the overall numbers of computers in schools is increasing, their productive use in elementary schools may be declining. In many schools the computer is used as a reward for students who complete seat work, and the reward frequently is the opportunity to play a computer game.

Initially, the plan was to follow a group of children as they progressed through three grades. The goal in this instance would be to describe their use of, and attitude toward,

computers over a long period of time. However, this focus was expanded to include a description of one teacher's use of the computer over a three-year period. Even though the study is in its initial stages, it is clear that change in the real world of schools does not occur in synchronization with a researcher's preconceived ideas of how it should occur. Also, teachers' espoused theories of instruction as well as their theories of action do not remain static. Thus, the expanded focus will incorporate a description of one teacher's initial espoused theory of teaching contrasted with her theory in action, with emphasis on the role of the computer in carrying out her ideas. Over a three year period, the changes that occur in the teacher's espoused theory of teaching and her theory in action will be described. Again, the emphasis will focus on the role of the new technology.

(3) The transfer of learning: Computers have been praised as great vehicles for promoting learning, but little research has been published indicating the nature of this learning. Most of the existing research has been simple in design. For example, a computer program purporting to teach an isolated skill is developed. To demonstrate the value of the program a pre-test/post-test research design often is used, and the mean gain scores achieved by a group of students using the program is taken as evidence of learning. These straightforward studies almost always show a gain in learning, at least as measured by the test used in the study. Such studies are flawed because they are frequently conducted for short periods of time, measure only one skill taught in isolation, and seldom attempt to show whether or not the skill is used by students in any real-world sense.

For example, phonic skills in reading can be taught in isolation, and the children's mastery of these skills can be measured, but whether or not these skills are used when a child encounters an unknown word is problematic. Many researchers assume that mastery on a test,

whether given by computer or traditional means, implies application in real-world situations. This is a naive assumption. Also, the role and value of isolated skill mastery in the total reading act often is not taken into account. In other words, if phonic skills are taught, is there any evidence that this learning affected the real purpose of reading--comprehension?

This study proposes to describe learning by seeking examples of children applying and using knowledge and/or cognitive processes that may have been acquired by or influenced by computer use. Because real learning is affected by many variables, both in and out of school, documentation using anecdotes and examples may not have the power and generalizability of more common research designs such as the one described previously. However, qualitative techniques may capture more complex relationships between computer-influenced learning and real-world applications.

(4) The exemplary use of software: The exemplary use of the Puzzler, a program developed for the ICON, will be demonstrated in order to create a videotape for teacher education purposes. The exemplary use of computers does not imply the creation and application of stand-alone software; instead, this idea is designed to show how teachers might apply the new technology in a manner congruent with normal teaching practices in the classroom. This demonstration will be devised to show how teachers might present computer applications of the taught principles, small group follow-up and discussion, and the application of the strategies through writing. The key to this exercise is that computers can serve as a natural aspect of the normal curriculum.

(1) Focus of Research: John Olson's research is in the area of computers and social and environmental studies (SES). He has two major areas of interest:

1. Computers and concept development. He is interested in the contribution software can make in helping children overcome conceptual barriers in science. There are certain basic concepts in science that students must grasp if they are to begin to understand science as a whole. Unless these concepts are well taught, prospects for widespread scientific literacy are not good. Computer-based learning may be critical here. If students can explore important systems interactively and be guided to notice key variables and infer relationships, there may be a role for Computer Assisted Instruction (CAI) in overcoming critical barriers to science learning. Given the importance of widespread scientific literacy, it is worthwhile to explore the potential of CAI in this area.
2. Computers and teaching routines. Understanding how teachers incorporate software into their teaching routines and the influences of types of software on how teachers think about the subjects they are teaching are the main research questions. Teachers have ways of teaching--routines which help them solve perennial problems in schooling. The introduction of computers may require new routines and recognition of the very goals to which the routines are dedicated, as well as the development of new ways to evaluate student achievement. We have found that pre-existing routines exert a strong influence over how computers are used in schools (Olson and Eaton, 1986), and it is those routines and the quality of the goals to which they are dedicated, that structurally influence whether or not microcomputers will be used to advantage.

Microcomputers have to be seen as part of the complex pattern of classroom activity which will not yield quickly to innovative doctrines unless the impact of those doctrines on

school life and the function of teacher routines is seen as a means to consider the potential of microcomputers.

(2) Research questions: The aim of this research and development project is to answer the following questions:

1. How can a computer simulation fit into classroom routines associated with integrated SES work?
2. What adjustments to their routines and to their curriculum do teachers have to make to use the available computer facilities?
3. What beliefs do students have about the computer as a source of information?
4. What do students focus on in considering their experience of the unit overall, and what role does the computer play in their assessment?
5. How do students think about the SES units and what role do their science experiences (including computer experiences) play as compared to the other elements of the integrated unit in influencing their thinking about the topic?

(3) Methodology: As a means of collecting data to address these questions an integrated SES unit on Fire was developed cooperatively involving the use of Flamelife, a computer program developed for use with the junior grades (Olson, 1985). The unit comprises four elements: science studies of combustion; social studies focusing on historical, cultural, and technological aspects of fire; language arts activities involving reading myths and making up myths about fire; mathematics activities in which students produce and interpret line graphs based on the experiment and on a simulation of the experiment on the computer.

After working on this unit in January, students produced graphs, models, interpretations of data, speculations about relationships, reports, and a folder of work in connection with the

unit. They have been videotaped doing the experiment, using the computer simulation, giving reports, and doing graphing.

Four students from each class (Grades 4, 5, and 6) have been interviewed and the teachers have been interviewed about their perception of the role of the computer in the unit. Currently, the results of the research are being assembled prior to interpretation. These data will form the basis of the first report which will attempt to answer the questions above.

Musical Explorations and the Special Needs Student

The research agenda of Rena Upitis, stated most generally, is to find ways of helping both teachers and students discover and develop their musical abilities. This includes creating and modifying existing environments where children can explore music in a playful manner, using a variety of tools to generate musical expressions in ways that are meaningful to the individual.

The project school has several teachers with a keen interest in music, including a music teacher, several classroom teachers, and the special needs teacher. Having spent time in classrooms and in discussion with these teachers, Dr. Upitis decided to focus her research on the special needs setting. Other teachers and students will play a role in the research as they interact with students in the special needs setting and as members of the larger school community.

There were three reasons for choosing the special needs setting. First, the kinds of musical experiences which are most conducive for learning and for making music on one's own should be of the same fundamental nature for all people, regardless of age or ability. Thus, one would expect that the research will show that the special needs students in the school (severely physically and mentally handicapped) can meaningfully partake in a variety of musical

expressions including creation, production, and listening, and learning new ways to communicate from these musical experiences. Second, there is great potential in working with teachers who do not teach music "per se", but who are eager to integrate music into the life of their classroom. Finally, the special needs setting in this school can be readily adapted to include music as a means of communicating significantly with other students in the school community.

(1) Use of the ICON for Music in the Special Needs Setting: The ways in which the ICON will be used in the special needs setting for musical development and exploration are determined largely by three factors:

1. the teaching philosophy and practices of the special needs teacher,

2. the underlying research/teaching goals of music education for "all" children, and

3. the availability of special input devices, and the possibilities of adapting input devices and software for children with special needs. Each of these three factors is briefly examined below.

1. The special needs teacher and classroom environment: The teaching philosophy of the special needs teacher is perhaps best characterized by her belief that any "real" learning has to have "intrinsic meaning" for the student, regardless of the age, level, subject, or ability of the student. This is reflected in her desire to provide for her special students the ability to communicate in ways that they themselves appropriately initiate, primarily through gesture. (For some of the students, there is the possibility of early vocalization or the use of picture

communication symbols.) Thus, one student may use a rubbing gesture while another may use a tap to initiate, carry on, and end a communication.

As part of her belief in the importance of meaningful communication, the special needs teacher has initiated activities involving other children in the school community, so that more positive attitudes toward disabled people might be developed. Thus, other students in the school spend time with the special needs children during specified periods in the week, as well as being responsible (one on one) for taking the special needs students in and out for recess periods.

Not surprisingly, the teacher believes that the materials in the learning environment should be highly appealing and potentially meaningful for the students. For all of the students, musical materials of one type or another tend to be "highly motivating." Music is the basis for many interactive games in her classroom, such as movement activities with music, where the student can signal to continue, discontinue, or switch to something else. Students also listen to music as a leisure activity. A number of different types of music are available to them, ranging from Baroque to popular (Whitney Houston), and children's songs (Raffi and Sharon, Lois and Bram), and country music. The children have developed clear individual preferences for music. For instance, one child always chooses to listen to the Country and Western station on the radio. The children also play a limited number of instruments, mostly of the rhythm band variety. Of the various instruments (bells, tambourine, rhythm sticks, triangle, shakers), the tambourine is perhaps the most effective. Many instruments are problematic because they are too difficult for the children to manage physically.

The special needs teacher sees the computer as having the greatest influence for her students in the areas of communication and in leisure activities, in both language and music related endeavours. The computer is seen as a vehicle for making links between the special

needs students and other students in the school, since by using the same machine, although not necessarily in the same ways, the non-handicapped students may come to see similarities between what they and the special needs students find interesting and motivating.

2. Underlying research/teaching goals: Most of the ways in which children experience music in the special needs classroom reflect the type of environment the investigator considers most stimulating for musical play and production. Music becomes truly meaningful to people only when they find their own meaning in music, through a number of experiences, including creation, production (including movement), and listening. Of these three ways of experiencing music, creation is perhaps the most powerful. One of the best tools for creating music, especially in early explorations, is the computer. However, the computer must be used in the context of a creative musical "playground" where children can explore a large variety of musical ideas using a number of tools, of which the computer is one. In this way, the computer can become a natural and integrated part of the larger musical experience.

The special needs teacher has already established listening practices, children are already playing instruments, and movement has been linked with music as a way of making meaning and communicating. Each of these three areas could be and will be developed further. For instance, a greater variety of listening music could be made available to the students (perhaps from contributions of other students in the school community, both live and taped), a better selection of instruments for the children to play could be provided (again, other students could play a role in this), and more movement-music activities could be developed. However, perhaps the most obvious missing element from the special needs music program is that the children have no way of creating their "own" music. It is in the area of music creation (including components of improvisation and composition) that the computer can play a significant role.

3. The role of the ICON: At present, there are several programs for music creation available on the ICON. They include MusicLand, Melody Manipulations, and more recently, MEdit and SOUNDSCAPES. All of these programs have several features in common. They allow the user to enter a musical idea or motif, and then manipulate the idea using musical transformations such as transposition, augmentation, and inversion. Larger musical structures can be built from the basic motifs, and the pieces can be performed on the computer/synthesizer. All of these programs are also much too sophisticated for use by the special needs children at the school. However, the basic components listed above could be adapted so that the special needs children might also experience and manipulate their own musical ideas.

One of the most versatile types of instruments commonly used for early improvisations are the Orff bells. The most important feature of Orff bells is that individual bells or notes can be added or removed from the set, so that the player can choose his or her notes (or scale), and then physically arrange the notes as he or she chooses. An input device for the special needs students is now being designed to capture this feature of the Orff bells, with the additional capacity of enabling the teacher or another student to program the note or sequence of notes for each "bell." Thus, the student may have three or four "bells" (actually touch sensitive pads), which could be physically arranged in any spatial arrangement desired by the student, and then played by touching the pad using whatever gesture has meaning for the particular student (e.g., rubbing or tapping). Because the notes of the "bells" will be programmable, the notes could be changed according to the various parameters offered by the music capabilities of the ICON, including pitch, duration, and timbre, within a number of musical structures (such as single notes, chords, single pitched rhythm patterns, or sequences of notes of varying pitches). This type of input device would allow the special needs students to communicate musically with other non-handicapped students, and in turn, non-handicapped

students could enhance the musical experiences of the special needs students by programming different musical sequences on the computer, or by using the same devices to make their own musical structures. The students could also use their own instruments, such as the tambourine, and play along with the computer-generated music, as one way of linking the computer with a more familiar music-making activity.

(2) Research documentation: The areas of research which are being documented reflect both the reasons for choosing the special needs setting, and the particular musical input devices to be developed for the ICON. Documentation is in the form of field notes, interviews, and videotapes of students taking part in various music undertakings. These areas are briefly outlined below:

1. Types of musical experiences of special needs students: As stated earlier it is believed that all students can benefit from music creation, production, and listening. The degree to which each of these musical experiences is possible and meaningful for each of the individuals in the special needs setting will be documented. In addition, these experiences will be compared with the responses of regular students in a similar music setting in earlier research.
2. The musical experiences and growth of the teacher: A detailed account of the teacher's musical growth will also be given. This will include not only the changes she makes within the classroom, but will also provide a view of her own musical development.
3. The integration of special needs students in the school community through music: The ways in which the special needs students and other students in the school come to interact and communicate using music will be described.

4. Adapting the computer for music in the special needs setting: A detailed account of how special input devices are developed, used, and modified in accordance with the needs of the students and the goals of the teachers and researchers will be given.

(3) Research profile: Rena Upitis will continue to focus her future research on helping teachers and students find ways to develop more fully musically, primarily through the creation of music, but also through music production (including performance and movement) and listening. Central to this notion of enhancing musical experiences is the cultivation of musical environments or "playgrounds" where musical ideas can be tried and manipulated using a variety of tools in socially stimulating settings. Within this philosophy, there are three particular foci which are relevant to the Schools, Computers, and Learning Project. They are described below:

1. Creating musical playgrounds: How can one help regular classroom, special needs, and music teachers develop techniques for teaching music improvisation, composition, notation, performance, and listening within a rich music "playground"? Her previous research, directly related to this goal, has examined children's spontaneous notational forms and other intuitive musical knowledge across several domains (verbal, symbolic, motor, aural), and has linked these empirical findings with classroom applications (Upitis, 1987). She has used the regular classroom as a research setting for developing methods for teaching improvisation and composition, using both non-computer strategies (e.g., Dalcroze movement techniques, Orff-based improvisation), and computer tools (e.g. MusicLand and Melody Manipulations). The school environment is ideal for the further development of this work, now going beyond the regular classroom to encompass severely handicapped students as well.

2. Designing cross-disciplinary projects: Working with several classroom teachers and other members of the research team in developing projects to bridge music to other disciplines is also a strong research interest. There are rich conceptual and structural links between music and mathematics and language. Music can also be a vehicle for examining issues relating to the social sciences.

3. Conducting longitudinal studies of individual children and teachers: The musical development of children will be tracked over a five- or six-year period, where the children have had early and continuing musical experiences of the type previously described. A complementary study would involve documenting the growth of one or two classroom teachers, including both personal musical growth and changes within the classroom environment.

Mathematics and the Computer

William Higginson's individual contribution to the Schools, Computers, and Learning Project is a long-term study of the way the learning of mathematics at the elementary school level is influenced by the presence of computers. During the first year of the project he will prepare, with the assistance of Susanne Ellis, a general report which will be entitled, "**Mathematics and the Computer in the Elementary School: Context, Claims and a Case Study**." This initial report will serve as a background study to future investigations. It will outline important issues for interested teachers and policy-makers, and suggest some possible avenues for fruitful exploration in teaching and research.

The first part of the report will examine views on the nature of elementary mathematics curricula. Of particular interest will be the centrality given in many curriculum documents to a process emphasis; that is, an orientation towards the constructive use of concrete materials, and the applicability of the content developed to the environment of the child, as well as

subject integration and an emphasis on problem solving. The perspective here will be both global and local. International sources such as the Cockcroft Report (UK), the National Assessment of Educational Progress (USA), the Coleman Report (Canada), the Second International Mathematics Study, and the recent sets of proceedings of the International Congresses on Mathematical Education will be cited. More specific and local documents such as those published by the National Council of Teachers of Mathematics, the Ontario Association for Mathematics Education, the Ontario Ministry of Education, and the Frontenac County Board of Education will be related to the international statements. Common priorities and problems will be noted.

The second section will consider, through an examination of the views of a range of leading computer educators, how the general aims articulated in the first section may be realized through the introduction of computers and appropriate software into elementary classrooms. The question is seen as an important one and there are a number of conflicting views. Major sources for citation will include the books by Robert Taylor and Cynthia Solomon and the report written for OECD by Jim Howe (1987). Taylor's three categories of computer use as "tutor", "tool", and "tutee" have been widely applied. The fact that the majority of the thinkers represented in this collection are mathematicians and mathematics educators is probably not coincidental. Solomon's consideration of appropriate computer environments for children deals exclusively with mathematics educators. The ideas of Seymour Papert, central to the thinking of both Taylor (1980) and Solomon (1986), will also be examined from the perspective of his book "Mindstorms" (1980) and his later papers. The British approach to this area, as represented in the journal "Micromath", which differs in important ways from the other ones described here, will be outlined. An analysis of the strengths and weaknesses of the different approaches will conclude this section.

The final part of the report will be a case study. The mathematics software available to the teachers and pupils on the ICON will be described. Pupil utilization of software will be documented, and detailed observations, including video records, will be made. The views of teachers will be noted regarding the suitability and effectiveness of mathematics software, and its relation to other parts of their mathematics programs. The report will end with a summary which will include a set of recommendations.

A Computational Perspective on Schooling

William Egnatoff's research is concerned with using computer talk to talk about using computers in education. In the Schools, Computers, and Learning Project, each principal investigator brings a research perspective, established or emerging, which frames the questions asked, the data gathered, and the way sense is made of the data. The perspective is determined in part by the researcher's world view (which is a value system containing utilitarian, aesthetic, scientific, recreational, and spiritual elements), in part by the particular subject expertise and interest (e.g., language arts, fine arts, mathematics, science, or computer science), and in part by the interest in the processes of the mutual adaptation of teaching, learning, and the new information technology. A computational perspective on teaching and learning is the basis for approaching questions about changes in patterns of teaching and learning when new information technology is brought into the picture.

Papert (1980) indicated that computer science is primarily the science of descriptions and descriptive languages. It seems appropriate, therefore, to assess the value of a computational perspective to researchers, teacher educators, teachers, and children in making sense of computer use in schools and in using computer-based experience to make sense of other experience. The research is timely in that it addresses the concern of David Olson (1985) that

computer use may erode the construction of personal meaning by forcing communication to be even more explicit than in writing.

(1) Research activities: The research has four interrelated components:

1. Constructing a framework of computer concepts: describing the essential and relational attributes of computers as instrumental, psychological, and social entities; entertaining notions from computer science as metaphors for human activity;
2. Describing school routines: describing classroom routines associated with the activities of the whole class, small groups, and individuals;
3. Explaining the inner workings of routines: studying how routines are introduced, conceptualized, expressed, learned, modified, and maintained; examining how the social context influences the routines and how the routines shape the social context;
4. Evaluating the computational perspective: searching for parallels between computational forms and the preferred forms through which children and teachers frame their activities.

(2) Research questions: The following are the research questions:

1. What understanding do children and teachers have of instructions, rules, and routines in the school and how is that understanding influenced by computational experience, self-image, and the social structure of the learning environment?
2. What sorts of computational descriptions of classroom routines best match the descriptions of children and teachers?
3. What values are attached to the structural elements of routines and how do those values account for the stability, robustness, and flexibility of routines?

(3) Participants: Several children will be studied closely as they pass through the primary and junior divisions. The work of two teachers, one primary and one junior, will be studied as they work with different classes over the years and as their own teaching evolves. Individuals will be studied in detail, and their peers in sufficient detail to understand the social structure of the school life of the individuals. The teachers have been identified as the teacher of the Junior Kindergarten/Kindergarten classes and the teacher of the split Grade 3/4 class. These two teachers provided leadership in the school by applying to participate in the project, and by serving as the computer contact persons for the board. The individual students will be identified after individual profiles have been drawn up of all children in the classes of the two identified teachers. (The profiles will be written collaboratively by the researcher, the teacher, and the children.) It is likely that two children will be selected from each Kindergarten class and four children from the Grade 3/4 class.

(4)Research intentions: There are four parts to the research that Dr. Egnatoff is currently conducting (February through June, 1987). First, he intends to select appropriate concepts from computer science which seem useful in describing classroom routines in a way which accounts for features of the environment and of past experience which shape learning. Second, he wants to gather enough data about each child in the two Kindergarten classes and in the Grade 3/4 class to write a brief character profile from which to select a few individuals for detailed longitudinal study. Third, data will be gathered on individual and social routines which form an essential part of classroom life and of learning activities, with particular attention to routines which seem to have computational analogues (routines which are clearly identifiable, well-established, modular, hierarchical, and having recognizable consequences; routines which are recursive, or have side-effects, or have bugs which can be fixed). These routines will be

construed as procedural knowledge in action maintained by valuative knowledge. Data will therefore be gathered on that valuative knowledge.

Of particular interest are routines of computer use within the classroom and in the computer centre, and routines of collaboration between the Kindergarten and Grade 3/4 classes through the establishment of reading buddies.

THE SCHOOL AS A PROJECT SITE

Fourteen schools in the Frontenac County Board of Education submitted applications to become the project site (May 5, 1986) The school that was selected is a typical elementary school in terms of computer experience. The school has one teacher who has extensive experience with computers and several with very little exposure to computers.

The school application indicated that most of the staff were willing to learn and experiment if they had the hardware, and that they wanted to integrate the computers into the life of the school. The school also had a population, for the purpose of the investigation, with just over 200 students. In addition, the school had the necessary space, including a room for a computer centre and a room for project staff and visitors.

After the selection of the school and ministry approval of the project, a motion was put before the board of trustees on August 21, 1986. The motion stated:

1. that the Frontenac County Board of Education approve participation with the Faculty of Education, Queen's University and the Ministry of Education in a Schools, Computers, and Learning Project beginning in September 1986 and extending for up to six years, depending upon available funding from the Ministry of Education;

2. that the board approve Hampton Public School (pseudonym) as the host school for the project;

3. that the board approve the secondment of a teacher to the position of liaison among the ministry, faculty, and board for the period of 1986-1989 at the base salary plus consultant allowance, with salary, allowance, and fringe benefits fully repayable to the board by the ministry;

4. that the board approve the hiring of a technician to provide support for the project, with salary and fringe benefits fully repayable by the ministry;

5. that the board approve a 1986 expenditure of up to $68,500 for the acquisition of microcomputer hardware and software, the support of the liaison teacher for the project, the technician for the maintenance of the project related hardware, in service expenses for staff and minor facilities modifications to the school, on the understanding that the expenditures are 100% refundable by the Ministry of Education.

At that board meeting of August 21, 1986, the motion was tabled, but discussion deferred because the trustees felt they did not have enough information concerning the project. However, on September 11 the board of trustees passed the motion after receiving a lengthy brief from the relevant superintendent. The brief included a copy of the ministry contract, an executive summary of the project, the memorandum that went out to principals regarding the project, a sample of an application form, a statement of projected costs and ministry funds, and 6 pages of responses to 11 questions asked about the Schools, Computers, and Learning Project.

The staff knew in September that their school would be the project site. The research contract was not signed and hardware had not arrived by then, so the project did not officially get underway until late October.

The description of the project site contains details on demography of staff and students, the programs offered, the physical layout of the school, and an account of the computer facilities and resources.

Demography of Staff and Students

The school is of average size for this board, having 206 students. What is uncharacteristic, though, is that it is almost at maximum capacity. In fact, it has been closed to outside transfers this year, a policy initiated in response to the large number of students per class (approximately 28).

(1) Staff: The staff of 20 includes 2 project support staff, 1 of whom is half-time, 8 classroom teachers, 2 half-time resource teachers and a half-time non-teaching library assistant, 1 principal, and a vice-principal. Both the principal and vice-principal are responsible for another school. Given this arrangement, the vice-principal spends his time predominantly at the other school (see table 1).

(2) Students: There are 206 pupils: 35 Kindergarten, 94 primary (Grade 1 to 3), 72 junior (Grade 4 to 6) and 5 special needs. The pupils are predominantly Caucasian, with English as a first language. Approximately 56% of the students live in single family dwellings and 70% have two parents living at home. The academic ability of the students falls within a wide range. According to one teacher, who has been teaching at this school for 16 years, the range becomes wider each year. There are an increasing number of discipline problems and children who have learning difficulties (see table 2).

ADMINISTRATION	1
principal	1
vice-principal (manages other school)	
CLASSROOM TEACHERS	8
kindergarten	1
primary	3
junior	3
special needs	1
RESOURCE TEACHERS	1.5
curriculum	.5
remedial	.5
library assistant	.5
SUPPLEMENTARY TEACHERS	1.5
French	1
music	.5
SUPPORT STAFF	4
secretary	1
NTA special needs	1
caretakers	2
COMPUTER SUPORT TEAM	1.5
computer resource teacher	1
computer technical support	.5

Table 1. Staff Distribution

Programs

All classes except special needs are withdrawn from regular class time for music. The children see the music teacher in the music room for two half-hour music classes and again for 40 to 45 minutes per week for primary or junior choir.

GRADE	TOTAL	BOYS	GIRLS
K	17	6	11
K	18	12	6
1	27	17	10
1/2	24	14	10
2/3	29	15	14
3/4	28	16	12
4/5	29	10	19
5/6	29	18	11
SPECIAL NEEDS	5	3	2
TOTALS	206	112	94

Table 2. Student Distribution

The primary and junior children have a French class every day for 20 minutes. The Grade 4, 5 and 6 children have extended French which involves 40 or 60 minutes of instruction time every day. Children at a given grade level are withdrawn for French at the same time which means that children in split classes have periods where only half of the children are with the teacher, while the other half are in French class.

Individuals or groups of children are withdrawn for remedial or enrichment work. Some of the junior children are involved in the central area program for the gifted. These children are transported to another school on 25 separate days during the school year. This group of children and others also participate in different enrichment units offered within the school. During the fall these children were involved in a science unit. A music enrichment class is being provided for the second half of the year. Other children are provided with remedial opportunites. However, the resource staff prefer to work with groups within the classroom (see tables 3 and 4).

Physical Layout

The school, built in 1954, contains 12 classrooms, 8 of which are presently used as such. The remaining 4 serve as a library, a French room, a music room, and a staff room. There is also a room 22.7' X 20' which is used for the computer centre. It currently houses 10 ICONS for group use. In addition to the principal's office and secretary's office, there is a computer office. The school is in the shape of an "H" with 2 classroom wings and the gym and computer centre located in the centre of the building (see figure 1).

Computer Facilities and Resources

The hardware and software used in the project are sufficiently new and complex that it was considered essential to have in the school people with strong curricular and technical expertise in educational computing. This section is a description of the hardware, installation, and maintenance of the system, available software, and people responsible for curricular and technical support.

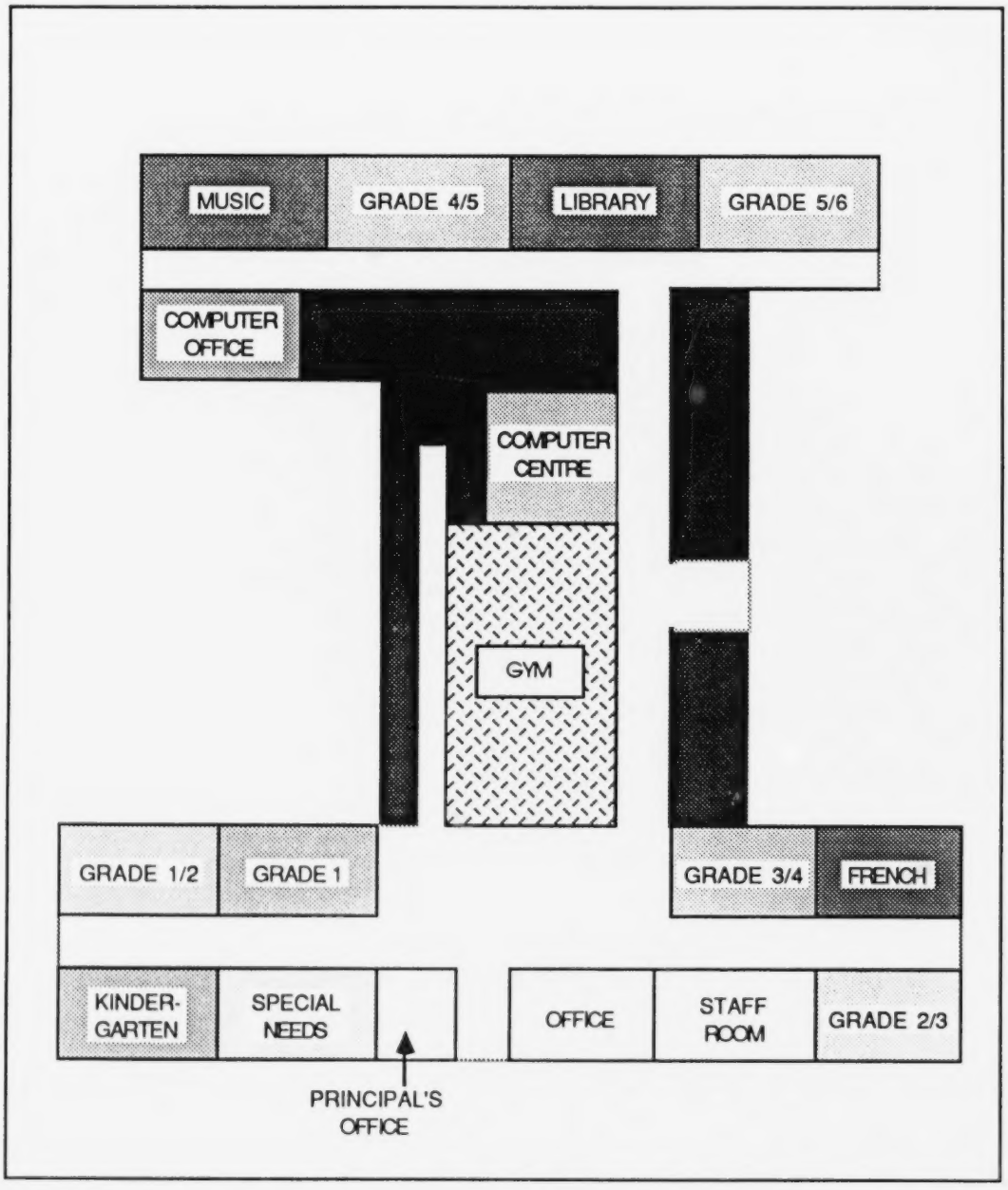

Figure 1. Floor Plan of the School

GRADE	FRENCH	MUSIC CLASS	CHOIR
K	------	1 hour/week	-------
1	20 min./day	1 hour/week	40 min./week
2	20 min./day	1 hour/week	40 min./week
3	20 min./day	1 hour/week	40 min./week
4	40 min./day	1 hour/week	40 min./week
5	40 min./day	1 hour/week	60 min./week
6	40 min./day	1 hour/week	40 min./week

Table 3. Whole Grade Withdrawal Programs

Hardware

The equipment provided by the Ministry of Education for the project meets the ministry's functional specifications, which require in part that the equipment support multiple users running a variety of programs simultaneously. Two factors have made the purchase of equipment meeting ministry specifications sufficiently attractive that approximately one quarter of all computers in Ontario schools are of this sort. First, purchase of such equipment is recognized as an extraordinary expenditure for which direct government subsidy, averaging approximately 75%, is available. Second, the ministry has funded software development for which it purchases licences for all Ontario schools. In this way, schools have no direct costs for software.

GRADE	GIFTED PROGRAM (CENTRAL AREA) 24 days/year	ENRICHMENT UNIT/TERM 1 3/4 hrs./wk	MUSIC ENRICHMENT (JAN. - JUNE) 40 min./week
K	--------	--------	--------
1	--------	--------	--------
2	--------	---------	---------
3	--------	---------	---------
4	1 child	5	9
5	2 children	4	9
6	2 children	4	5

Table 4. Small Group Withdrawal Programs

The system used for the project is the ICON computer coupled to a LEXICON file server. The ICONs are connected in a network. The CEMCORP ICON network system was created specifically for educational purposes. Its hardware was designed to be rugged, tamperproof, ergonomic, simple to install, and easy to service. The software can be accessed directly through the operating system QNX or through the user-interface called Ambience. Detailed descriptions of the parts of the system follow:

1. ICON: A 512K microcomputer containing a 16-bit microprocessor (Intel 80186, running at 7.16 MHz). All ICONs have a standard keyboard with a separate numeric keypad

and additional keys for producing commonly used French characters. (Other special characters, not on the keyboard, may be produced through special software.) All ICONs have a trackball built into the right corner of the keyboard to allow easy movement of a tracker on the screen. It is an analog-to-digital converter, used to input positional data to direct the cursor; it is similar in function to a mouse.

2. Network: ICONs may be connected together in a network for common sharing of resources such as hard disk, printers, and modems. A maximum of 16 ICONs on each network is currently recommended.

3. LEXICON fileserver: A central fileserver containing memory devices for the system. It can support a number of ICONS through the high speed local area network. It contains 10 or 64 megabytes of hard disk, a floppy disk using 5 1/4 inch double-sided, double-density diskettes, a disk controller, and a main logic card with an Intel 80186 microprocessor. The LEXICON supports all networking tasks and shared use of common output devices such as printers and modems.

4. Ambience: The user interface program developed by the ministry which provides menu-driven access to ICON functions. There are three levels of Ambience: student, teacher, and site administrator.

The student Ambience interface provides menus of programs available to students. The individual uses the trackball to point to the desired option and presses an Action key to select it. The student may choose to make floppy disk backup copies of work or may delete finished work from the hard disk through the appropriate Ambience menus.

Teacher Ambience gives access to utilities that permit modifications to existing programs for specific student/class use. These programs then would be available to students through the common Ambience interface.

The site administrator portion of Ambience permits easy access to administrative chores such as loading and deleting programs from the fileserver, setting up student logins, and identifying classes of students.

5. QNX: a Unix-like operating system, offering advanced features such as a tree structured file system, simultaneous execution of programs, multi user support, and quick response to a variety of input and output devices.

The school has 27 ICONs, 2 Commodore 64s, a VIC 20, and an Apple //e. The ICONs were provided by the project, and the other four computers had been acquired previously through the assistance of the parents' school council and centrally allocated funds for instructional computing.

There are 10 ICONS in the computer centre, and the remaining 17 are distributed throughout the school (see figure 2). There are 2 64 megabyte LEXICON file servers and 4 printers currently in operation (February, 1987). Presently, printers will not work in Ambience at individual workstations. This presents some inconvenience and results in the use of only 2 printers for the students. The central printer is located in the computer office. Work produced in 6 classrooms and in the computer centre is printed on this printer. Currently, 2 classrooms and the library are on a separate fileserver. As a consequence, their work is printed on a printer in the Grade 4/5 classroom. There are 2 other printers used for administrative purposes, one located in the school office and the other in the Kindergarten room (January, 1987).

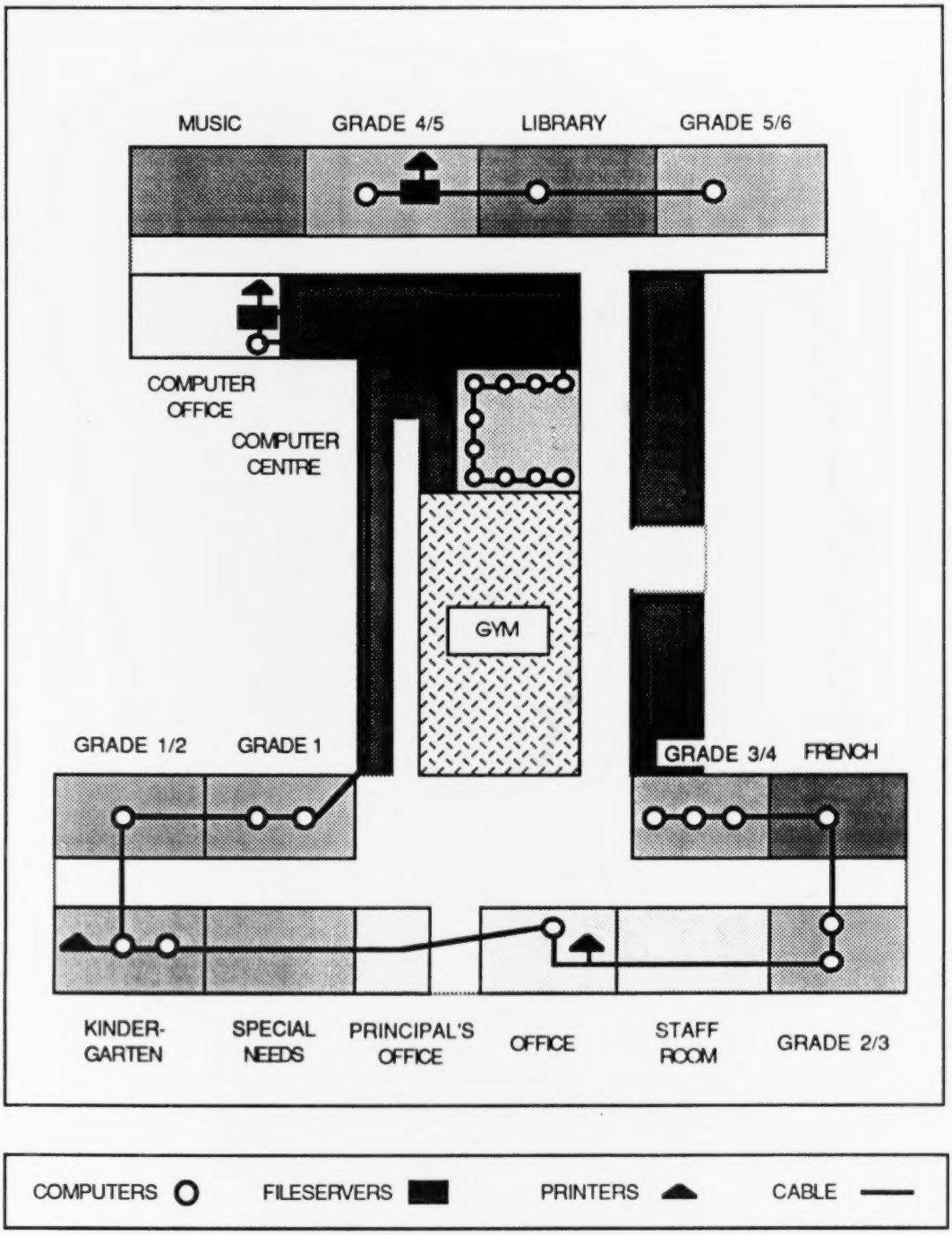

Figure 2. Computer Layout

The school also has 2 large monitors, 4 music synthesizers, a colour printer, and a modem. Arrangements are being made for some computer adaptations for the special needs children (see tables 5 and 6).

One LEXICON and three ICONs were installed at the Faculty of Education for project team use and demonstration.

Installation and Maintenance

The computers arrived in late October. On November 8, 15 machines were set up in the centre. The school was then wired so each room had cable running to it and could therefore operate workstations. The plan was to connect all 27 workstations to a central fileserver, using a second fileserver as backup (e.g., for storage of material).

The computer resource teacher believed that the entire system should be part of the same network so pupils could have access anywhere in the school to files that they had created. Work done either in the classroom or in the centre then would be accessible. Duplication of software is also unnecessary with one network, which saves on storage space.

Installing cable throughout the school was technically complicated. The computer resource teacher and another staff member managed to install the system, although the process was costly (approximately $10,000) and required roughly 100 hours of installation time.

Major problems that were experienced included the following:

1. the system "hung up" approximately once or twice every day for roughly 20 minutes at a time;

GRADE	OTHER COMPUTER	ICON	PRINTER	FILESERVER
K	X	XX	X	
1	X	XX		
1/2		XX		
2/3	X	XX		
3/4		XXX		
4/5		X	X	X
5/6		X		
FRENCH		X		
LIBRARY		X		
COMPUTER OFFICE		X	X	X
COMPUTER CENTRE		XXXX		
OFFICE		X	X	

Table 5. Distribution of Computers

2. two workstations were extremely slow when loading;

3. booting up the workstations in the morning was extremely slow;

4. sometimes the Grade 4/5 workstation would not work when the Grade 3/4 workstation was in operation.

workstations	27
fileservers	2
printers	10
color printers	1
large monitors	2
modem	1
music synthesizers	4
special needs adaptations	being developed

Table 6. Computer Equipment

On December 6, 1986, after a month of complications, the team tried removing some machines from the network. At the end of December they removed two workstations from the network and temporarily connected them to a fileserver. A printer was hooked up to this second system in January. In mid-January another printer was put into the Kindergarten room. As noted above, this printer can only be used by staff in QNX. The team intends to link all workstations into one network as soon as technical difficulties are overcome (see figure 2).

Software

The software funded by the ministry is distributed to Ontario schools by TVOntario, and the Ontario Educational Software Service (OESS) of the ministry. Although each school board normally receives only two copies of new software (to be redistributed internally), the project school receives copies directly. Furthermore, special arrangements have been made with a few

software developers to receive near-final versions of new products. As a consequence the school has most of the latest available software for use on the ICON.

All of the software is, or will be, available in French as well as in English. However, the French teacher in the school believes that almost all of these programs are inappropriate for use with her core French and extended French classes. She notes that the programs require reading skills beyond the students' ability.

Access to software is a problem. Gaye Beckwith noted, "From the software that I have seen over the last few years we are somewhat stifled because we do not have access to all of the software available on the market for education." He added, however, that, "A month ago I would have said that we didn't have [a newspaper editing program] and now we have Micro News [on the ICON]."

While most software is accessed by means of the Ambience user-interface developed by the ministry, some is accessed directly through QNX.

Given the present constraints of Ambience, the number of programs available on the fileserver at one time is limited to 30. These programs will change as new software becomes available, and as staff select software to meet changing needs.

THE SCHOOL AND THE COMMUNITY

The Neighbourhood

The school is located in the centre of a quiet residential area. The homes are approximately 30 years old, built about the same time as the school. At one time, the students of the school all lived in this well established neighbourhood, which was comprised of upwardly mobile professional families. The neighbourhood's population has remained stable, resulting in a drop in enrolment at the elementary level. More recently, however, the number of students has dramatically increased. This reflects new building developments in two locations adjacent to the original neighbourhood. The new housing developments exist within the same boundaries. However, they are a different type of residence and therefore the population differs in terms of stability and socio-economic level. Both developments are multiple rental housing units. One is a series of townhouses and the other an apartment complex.

The streets that border the area are major thoroughfares with business developments. The area contained within these boundaries is completely residential, without stores or municipal buildings such as libraries and recreation facilities. The school is in the central area of the board, although considered to be outside the central core of Kingston. The school is situated across from a school operated by the Frontenac, Lennox, and Addington County Roman Catholic Separate School Board. Both elementary schools provide climbing equipment. There is a small public park between the schools with additional climbing equipment. Given that there is only one other park, with very little equipment, the school's facilities have become the neighbourhood gathering area for children and parents. As the principal suggests, "It is the focal point of the community."

The parents, principal, and teachers describe the school as a "neighbourhood community school." The community orientation of the school seems to have strong historical roots. The cohesiveness and stability of the neighbourhood have contributed to a strong parent group. As well, an earlier principal apparently set a tone of community and togetherness which has continued. However, according to the principal and parents, the parents and children living in the new housing developments are not being fully integrated into the neighbourhood.

The Parent Group

The parent group is described as "active" and "involved." Three indicators of this are:

1. twelve parent volunteers come into the classroom to help the teachers and to supervise in the computer centre;

2. a strong parents' association; and,

3. almost all parents attend school events (e.g., music performances, Fun Night and Open House.)

The principal also noted the visibility of parents. He says that parents are always in the halls, because a lot of them call for their children at school. This gives them the opportunity to talk with the staff. According to the principal, a social basis develops through this contact. As one parent said, "The school is easy to get into. There are always parents wandering around. It's open and fun." The principal and staff seem to encourage parents to come into the school and classrooms. The principal appreciates parental involvement, "The parents are extremely supportive ... and not aggressive," he says. One teacher said, "There's a fantastic

amount of parental support - some may say parental interference ... 99% of parents are very supportive."

The parents' association has been very supportive of the school and its programs and policies. Through fundraising, the parents have provided $2,500 for purchasing computers and $4,000 for a progressive playground which was matched by a Kiwanis Club grant. The parents' association is good about allocating money according to the suggestions of the principal and staff.

For example, during the last year staff requested funds for the library, language arts, physical education equipment, science materials, and a development fund for field trips. The parents' association provided $500 for each of the library, science, and language arts programs and gave $400 for physical education materials. They did not provide funds for field trips, although they made $50 available for each class for instructional purposes.

Over the years, the parents have been vocal in support of a separate music program. In the past when it was cancelled they organized a lunch hour music program, paying the music teacher themselves. Now the half-time music teacher comes out of the usual staff allocation, which puts individual class/teacher ratios higher. As one parent suggested, "It's our best feature. We have the best music program in the board... Parents put pressure to have [the current teacher] or would if it was in danger of being cancelled."

As one teacher explained, if the staff tried to end this program and put teacher resources back into classes they could have one more teacher and smaller class sizes but, "The parents would object and put a lot of pressure on us."

The parents also have supported the computer initiatives and the computer-enriched environment that the project provides. When given an opportunity to respond to whether they wanted their child to participate, only 1 of the 155 families raised a concern, which was that the ministry should not be spending this large amount of money on computers and that they would be better off putting it in printed material. Even so, this parent agreed to have her child participate in the computer-based learning opportunities.

THE SCHOOL AND THE BOARD OF EDUCATION

Board Resources

The Frontenac County Board of Education has 39 elementary schools and 9 secondary schools. There are 510 elementary teachers and 9647 elementary pupils, 418 secondary teachers and 7326 secondary pupils. The board administration includes a director, an executive assistant, 5 superintendents, and 5 assistants to the superintendents. There is also an arts coordinator and 9 consultants, 2 of whom are half time (see table 7).

The school receives $.56 per child per school day for supplies which results in a budget for the project school of $13,460 for all supplies. Although low, this budget is typical of other boards' allotments. What is perhaps atypical is the Frontenac board's recognition of this and its attempt to provide more resources by creating plans to increase all of the schools' buying power. The superintendent for the central area has a plan to purchase materials in bulk that are highly recommended by staff, and then make them available to the board's staff at 70% of the board's cost, which is 20% below present cost. The result is that schools can purchase these materials for roughly 55% of what they cost in the past. If the school chooses to purchase these recommended materials, the school's buying power, will be doubled, thus making a substantial difference to the materials available in the school in subsequent years. In addition, the board saves administration costs of approximately $11.00 on each purchase order. This plan ties into the board's "coaching model" of staff development in that individuals can be directed to other teachers for consultation regarding the use of these materials.

DIRECTOR OF EDUCATION (1) EXECUTIVE ASSISTANT (1)

SUPERINTENDENTS OF EDUCATION (5)

WESTERN AREA	CENTRAL AREA	NORTHERN AREA	EASTERN AREA	BUSINESS SERVICES

ASSISTANTS TO SUPERINTENDENTS

INTERMEDIATE/SENIOR (1) PRIMARY/JUNIOR (1) EDUCATIONAL SERVICES (2)

PERSONNEL (1)

COORDINATOR

THE ARTS

CONSULTANTS

LANGUAGE ARTS	1	CENTRAL AREA	1
GIFTED/TALENTED	1	EASTERN AREA	1
OUTDOOR EDUCATION	1	NORTHERN AREA	1
COMPUTER	.5	WESTERN AREA	1
FRENCH LANGUAGE	.5		

Table 7. Administration and Board Resource Staff

Board Policies

Our understanding of board policies provides a backdrop against which to view the work at the project school. Currently, the board is implementing policies in the areas of: English language instruction, mainstreaming, staff development, and staff allocation. Each of these is now considered in greater detail.

(1) Language Policies: The board is emphasizing language policy (listening, reading, speaking, and writing) and is now into the second year of a five-year plan. New policies have been implemented and teachers are attending in-service sessions. As the area superintendent suggests, "The board is in a period of consolidation, where there will be no new board language guidelines for a while. Reaching this stage puts the emphasis on the classroom and examining whether policy has been implemented." The superintendent comments further that, "Curriculum has reached a consolidated point where it flows back to the schools."

The superintendent is concerned that teachers provide more opportunities for reflection on writing, create an audience in the classroom, use writing folders, which is now board policy, and read more often to children.

(2) Mainstreaming: The board is moving to integration. A number of segregated classes have been eliminated. Only special classes for extremely developmentally and physically handicapped children will continue.

This change parallels a change in the number and role of the in-school curriculum resource teachers (CRTs). The number of such teachers has increased in proportion to the

number of staff eliminated as teachers of segregated settings. There are now 45 curriculum resource teachers, and the ultimate aim is to have one curriculum resource teacher per school.

(3) Staff development: The board is committed to staff development using a coaching model. Fifteeen hundred teacher release days are provided for in-service sessions which during this year, involved teachers of Kindergarten, Grade 1, French, curriculum resource persons. Each year different grades and subject areas will be involved in the in-service.

(4) Staff Allocation: The current policy is to transfer staff once they have been at a school for approximately eight years. This is an issue for the project because there are a number of staff who have been at the school for more than eight years. If the policy is not carried out at this school other schools may question the differential treatment. On the other hand, the administration contends that individuals at the project school are experiencing change and are growing professionally, two key objectives of the transfer policy.

Board Computer Initiatives

The board is described by staff members as being highly supportive in the area of computers. According to the area superintendent, the strategy is to support the initiatives of the staff, "We are very keen to support enthusiasm rather than wait for bureaucratic processes. We are growing where interest is. This permits and encourages experimentation." The board reduced the computer consultant position from full to half-time.

The board has a strong Computing Council consisting of 25 very keen individuals. Each school has a computer contact person. These individuals are neither paid nor given any

teaching reduction for this responsibility. They have, in the past, been given some release time for meetings and workshops, but not for their role or for in-service time spent with teachers. However, starting next year they will no longer be given this release time.

In 1983, the board enabled each school to purchase one computer (either a Commodore or an Apple), a printer, and two software programs (Logo and Bank Street Writer) by offering a subsidy of 50% of costs. The Computing Council produced a policy statement in 1984, a resource book, a newsletter, a software catalogue, and Logo activity suggestions. The Computing Council also provided an Apple computer for two to six months to teachers who had developed a proposal for creative use.

At this time there are 300 computers in the board, giving a ratio of students to machines of 50:1. The ratio at the project school is 7:1. Clearly Hampton Public School is a "computer-rich environment."

A PORTRAIT OF HAMPTON PUBLIC SCHOOL

The project team works in collaboration with school staff whose goals and methods are central to the project. It is their work with computers that provides the subject of these studies and the basis for understanding how the schooling process, as it is now, and the potential of computers for the future, can interact productively.

In this section of the report, profiles of the teachers and portrayals of the classrooms involved in the Schools, Computers, and Learning Project are presented. The portrayals, taken from videotapes filmed in January, provide a written account of classroom dynamics. The accounts present only a glimpse into the classrooms; however, they provide the reader with insights into the nature of student-teacher interaction and peer involvement, the type and progression of activities, an indication of teaching style and methods, and a description of how computers are being used in the initial stages of the Schools, Computers, and Learning Project.

The profiles were synthesized from two interviews conducted by two different members of the research team The descriptions are designed to show how the teachers, at the initial stage of the study, described their approaches to education, including such important aspects as room set-up, methods, materials, routines, and attitudes towards children. As well, the descriptions contain each teacher's early impressions of the project, including statements about the potential use of computers. These initial profiles are important to this investigation because they will become the benchmarks for later observations concerning the impact of the technology on the school.

The Primary Division

The Kindergarten teacher

Mrs. Dexter has been teaching for 20 years, the last 9 of which have been at this school. For a total of 12 years she has been a Kindergarten teacher and prior to that she taught the junior grades. She has taken several board computer courses and has completed the first two of three parts of her Primary Specialist certification.

Mrs. Dexter enjoys working with other staff members provided that there is sufficient planning time. She has developed several thematic units with other teachers. She worked with the primary staff on a bear unit in the fall and in the spring is doing a special unit on Clifford the Big Red Dog with the Grade 2/3 teacher. She has also arranged to have reading buddies for her students with the Grade 2/3 class and hopes to develop a system of computer buddies.

Mrs. Dexter has been involved in the Kingston Jaycettes, a leadership training and community service group in Kingston, for the past five years, during two of which she served as president. She has taken and organized several leadership training workshops through this group. She is also the vice-president of the St. George's Choir Guild.

Mrs. Dexter recognizes that her approach has changed over the years. Her classroom is now more activity-centred, and in it she supplies the materials, and both she and the children supply the ideas so that children will learn through stories, songs, discussion, and from each other. In addition to children learning social skills through social interaction, she believes that they learn about other things through talking and discussion. "One child might not have thought of doing something, but once his friend was doing something, he then got the idea and built on it and then they'll build on it together."

In the past, because she felt pressured to make sure that the children could do certain things by the time they entered Grade 1, she would do the same things with all the children whether or not they were ready. Now she feels that, "That's not my job. My job is to take them from where they are and try and make them go ahead and when they're ready to do it they will do it." This way she says they are further ahead, less frustrated, and certainly talk a lot more, but she feels that is not bad. She used to be concerned about the amount of noise. Now she looks at what they are doing and finds that much of it is constructive noise. She stresses that it took her a while to sort that out.

Mrs. Dexter tries to provide a friendly atmosphere, where children are not afraid to experiment and are free to make decisions about what they want to do; she is helpful but does not do everything for the children.

Mrs. Dexter was enthusiastic about this project from the beginning, and was one of the staff involved in writing the school's proposal for the project. When the regular computer contact was on leave for a year Mrs. Dexter served as the computer contact, attending all the computer meetings. She believes that during this time she learned much about how to use computers as teaching tools. She has some concerns about the amount of time the project will take and some concerns about the availability of software for Kindergarten students, given their limited reading abilities. For example, she points out that many programs tell students when their work is correct. This is obviously a problem if the students cannot distinguish between the words correct and incorrect. She suggests that a pictorial or visual cue would be more appropriate.

The Kindergarten class

Shortly after Monday morning exercises the children are gathered in a circle "Marching 'Round the Alphabet" walking around a set of lettered blocks while a song is played on the phonograph. When the music stops, they dive for the nearest letter, and Mrs. Dexter goes around the circle, checking that they all know which letter they have picked up. Then the song begins again, and the process is repeated. When this group game is finished, Mrs. Dexter says, "Now for activities today, we have an alphabet.match on the one computer, and the other two computers are free. The writing centre, patterns, printing, playdoh, sandbox, our winter books are still here, and any of the activities you want to play at the front" (see figure 3).

The sandbox is most popular. Seven children, four boys and three girls, go to it, although only four are allowed to play there at a time. In two or three minutes, Mrs. Dexter checks out the sandbox, and says, "OK, how many are supposed to be here?-- four?--four--? well, maybe we'll have to go back and look at the cards, I think; you count and you'll find there's more than four--seven--seven-- that's right." (This refers to a system of cards similar to library cards; there is a board at the front of the room with pockets for each student, and in order to reserve an activity, a student can take one of the cards and put it in his or her pocket. Thus, there will be four cards available for the sandbox, two for the doll-house, and so on.)

One of the students is working with the Face Building program on the ICON computer, starting by watching a built-in demonstration of the game. "Oh Mrs. Dexter, look at what it did, two different eyes--it gave me different eyebrows--now it's giving me different backgrounds." A little later, Julie writes with StoryMate on another ICON, trying to reproduce class names from large cards. Jeff shows up as "Jeff." Heather comes up next, and Julie says "I already know how to do Heather," but she finds it difficult to coordinate the cards, the keyboard, and the monitor. After trying "hayire," she modifies this to "hayiyeya," which she accepts.

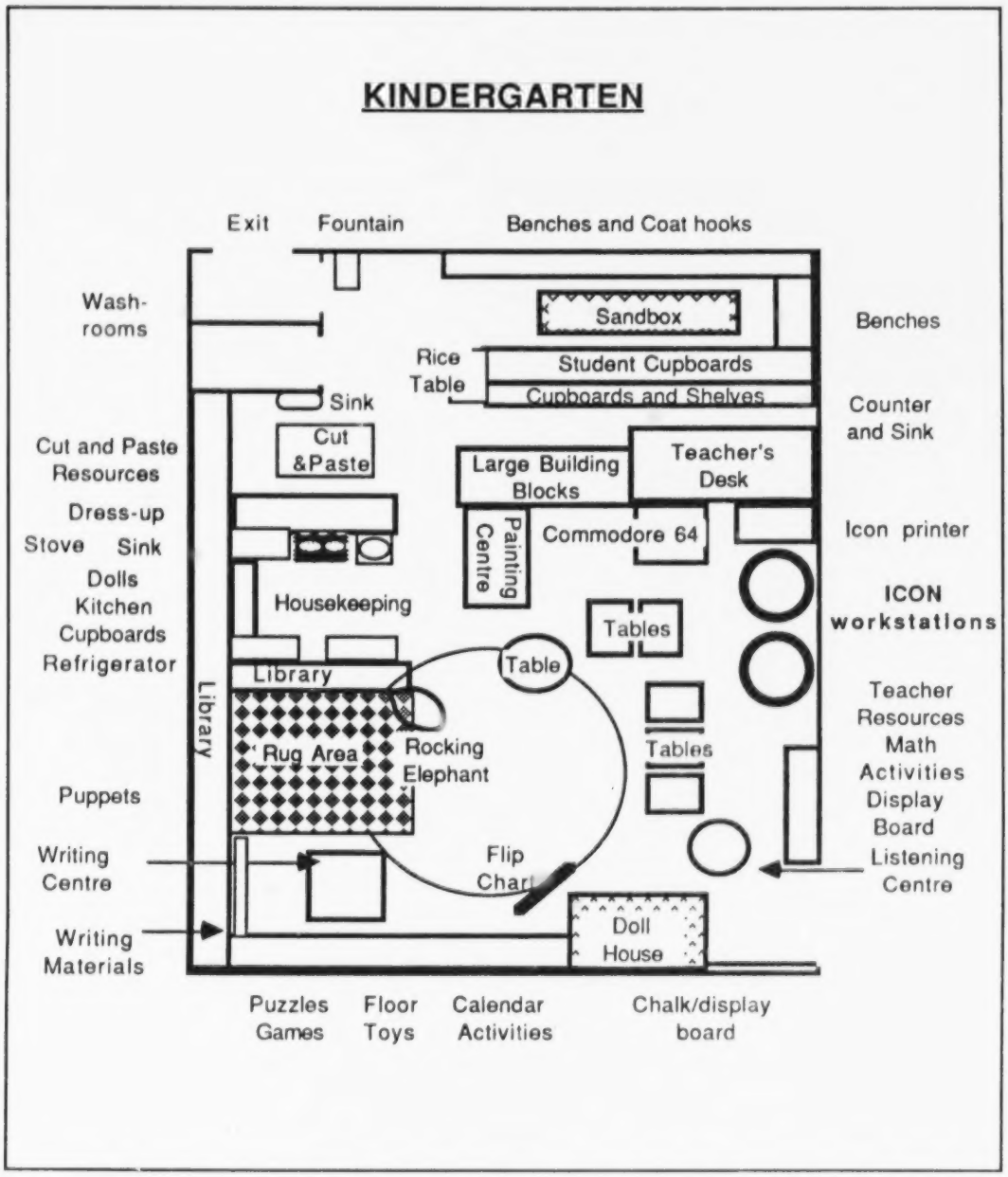

Figure 3. Kindergarten Class

The boy drawing the face has an inspiration, and uses the eyebrows to produce a very good moustache, and continues by using dozens of eyebrows to draw a beard. Mrs. Dexter sees this and comments, "That's an interesting idea because they didn't have a beard on there. That's a very good way to improvise, making your own beard."

There is a new girl in the class. Barbie has been around long enough to catch onto the routines, but is not yet fully integrated into the class. Mrs. Dexter gives her a plastic bag with about 15 pairs of mittens in it (as well as 3 odd mittens), and Barbie begins to match them on the floor. Another girl runs up to help, but Barbie says, "No!" A third child says, "She can do it by herself." Barbie then works industriously on her own, and a few minutes later has matched all the mittens which are part of a pair. Meanwhile, two boys are playing with fishing poles with magnets on the end of the strings, fishing for different coloured metal fish marked with numbers or letters. (One of them makes a good pun when he gets a big fish, saying "Holy mackerel!", but it is not clear whether this is intentional.) When Barbie finishes with the mittens she puts them all back in the bag, takes one of the fishing poles, and starts to fish. Mrs. Dexter is wearing a bright red sweater, and when Barbie catches a red fish, she says, "I got your colour." Ashley, who has been playing at the doll-house nearby with another girl, now comes over to help Barbie fish, and when Ryan leaves, Ashley pounces on his pole.

The girl with whom Ashley was playing starts a monotonous repeated chorus of "Ashley, are you going to play Beverley with me?", but Aisha refuses, smiling and shaking her head. Barbie is tired of fishing and abandons the game.

Mrs. Dexter says to her, "Well yeah, but Barbie, if you're too tired, you just don't leave an activity out. What you have to do--if you leave it on the floor pieces are going to get all lost. Is Ashley going to play with that game now? OK, Barbie, you put the pole away and Ashley will play with it. Put your fishing pole away."

Barbie moves to one of the ICONs, and Mrs. Dexter brings over another girl to help her call up and use IPAINT. The program is slow in appearing. When the paint pots finally appear on screen, Barbie bounces up and down and says, "Now we're done. Now I'm going to paint."

"No," says the other girl, "we've got to wait."

After the tree is drawn, Barbie asks, "Now I get to paint?"

The other girl says, "Go up here, and when you get here press ACTION." Then she leaves Barbie to work on her own.

Barbie makes a small mark on the screen and announces, "I made a line." A little later, Mrs. Dexter comes by to help her, adjusting the monitor as well as she can to Barbie's height.

The Grade 1 teacher

Mrs. Jensen has been teaching at this school for 15 years, and has taught primary age children for 25 years. She has been involved in developing a primary language curriculum for the board of education, conducting workshops on language and puppetry, and in developing two or three primary units each year. She caters to a wide range of abilities by providing materials for play, work and exploration. Interestingly she claims, "I'm really quite structured." However, she stresses the importance of being flexibile within a structured environment.

Learning occurs through self-motivation, and for some children, she says, repetition is an essential part of their learning, and language development and some mathematics development occurs through social interaction. The teacher's role in the learning process is

one of guidance and providing opportunities, supported by adult volunteers who play an important role in the learning environment.

Mrs. Jensen suggests that her teaching style has changed over the years. At one time it was very structured. As an example, she points out that she does not use reading groups as much now as in the past. Reading now involves "read along" and theme studies, although basal readers are used along with other books. "I believe I teach well from basal readers," she says. However, textbooks are being used less this year than last year, and students are organized into heterogeneous groups, containing students with various reading abilities, which encourages peer teaching.

In terms of math she says, "We all work at math at the same time. We work together at the level that we're at. Everyone does the same type of mathematics activity and everyone gets a star after corrections are made." Mrs. Jensen does not use stickers and labels because she feels they tend to create a competitive atmosphere.

Planning takes place according to the current theme that is being used in the class. Activities are planned around the theme in keeping with the interests of the children, and stations are designed so that two or three groups of students can work independently, using written instructions as a guide.

Computers are not new to Mrs. Jensen's classroom. When the project began, she already had a VIC 20 in her classroom. At the start of the Schools, Computers, and Learning Project, the ICON computers are fitting in very well; students are using various math games, the IPAINT program, and Story Mate, and parent volunteers are coming in to help the children. Her aim is to have the computers completely integrated into the classroom.

The Grade 1 class

It is approximately 11:30 on the second Monday of the winter term. A careful glance around the entire classroom shows a multitude of children's work and resources. On the windows are paintings from a previous activity - so many that almost all of the windows are covered. The two ICONs are next to the home centre, and the VIC 20 computer is placed directly opposite (see figure 4).

After listening to a short story, Mrs. Jensen's class gathers on the rug to hear how the rest of the period will be used. A number of activities will be occurring concurrently, as is usual for this class, and some children will need to work independently. However, since most of the resources are readily available to the children, this will not be difficult.

"First of all," says Mrs. Jensen, "I want to start with all of the people who did not have a chance to sponge paint on Friday." Mrs. Jensen's face is animated as she talks, and her hands mimic the action of sponge painting. "Would you put up your hands please." Those who have not had an opportunity to sponge paint the mural are directed to the hallway where a volunteer is waiting. Some of the students take off running and Dennis, one of the pupils, emits a loud and apparently happy "Glurp" sound.

Mrs. Jensen is talking to the group remaining on the rug. "Now," she says, "For the rest of us, the first thing that we need to do is to finish up our characters that we were cutting." From a chair beside her, Mrs. Jensen takes a pile of paper and drawings in progress and places them on the floor. Children cluster closer to her, peering over their characters.

The children destined for the painting are putting on their paint shirts. Some have already left the room. Dallas and Dennis start pushing each other slightly. It sounds like a, "You did.

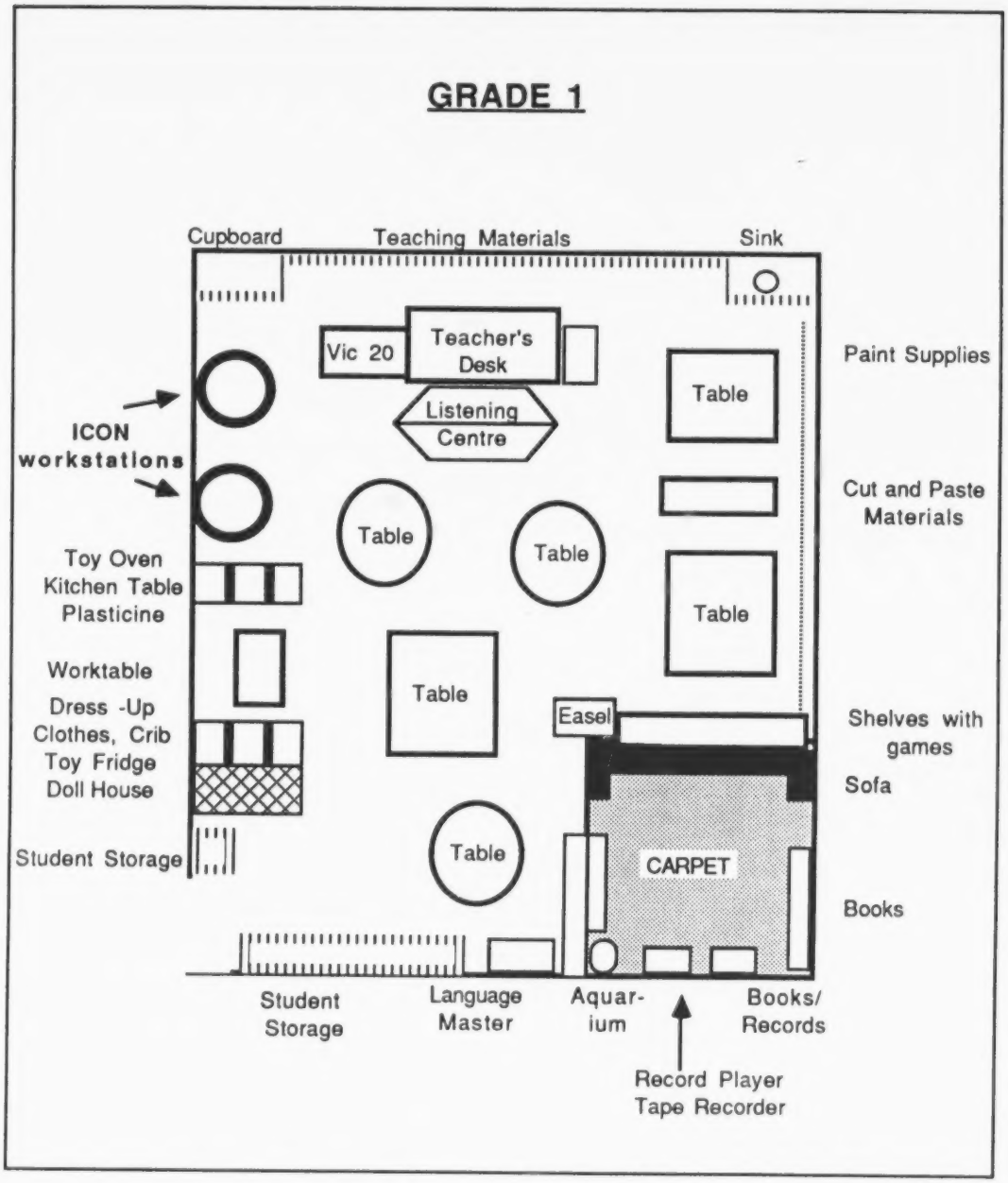

Figure 4. Grade 1

No I didn't," scenario as Dennis rebuts, "I didn't." As quickly as the argument starts it is diffused, without any attention from Mrs. Jensen or the other children. Little time is lost getting ready for painting, a popular activity in this classroom. Mrs. Jensen then leaves the classroom, presumably to help set up the mural painting in the hall.

Brent, Donnie, and Jason have chosen to work together at a table and are engaged in drawing figures. "Aren't you going to show me how to draw?" questions Brent. Donnie is encouraging. "It's easy," he says, and his repeated offers of help in drawing are genuine and rather touching. The response of Brent, "Just show me, O.K.?" implies that Brent wants to be the only one who is shown, and also that he places a high value on Donnie's potential help. Brian has something in front of him which he pretends is tape with his name on it. He appears pleased with this fantasy as he glances up and smiles shyly.

At another table, several girls are working on their drawings. Beatrice stands her drawing on the floor, apparently enjoying the illusion of it walking. The rest of the pupils are involved with painting at the centre in the room. There is an atmosphere of purposeful activity.

Joel, Kyla, and Brin are finding paper at the painting centre. Someone comes across a paintbrush of questionable appeal. "Ughooo! Look at the paint brush," someone yells. It is difficult to see what is happening because they are partially hidden by a garbage bag filled with materials. Another child is admonishing Brandy saying, "Did Mrs. Jensen tell you to do a few trees?" Moments later Mrs. Jensen reappears in the painting area to retrieve a wad of paper for drawing. Accompanying her are two or three children who are waiting for materials.

Mrs. Jensen then becomes involved with Noel and Sasha who want to use the IPAINT program on the two ICONs as a free activity while the other students continue their mural work. As usual, there seems to be a certain amount of discretion on the student's part in

deciding when the work is completed. The computer is being chosen before any other free activity, and there are more children wanting to use the ICONs than there are computers. None of these children sees the VIC 20 as an alternative. Some children apparently prefer to work in pairs while others enjoy using the computer independently. Kyla helps Sasha, but Noel works alone.

It is also apparent that the students who are just learning to read need help with the program menus. Sasha's requests for the next instruction carry a sense of urgency. When Sasha's screen is ready, she is impatient for the next instruction, and it appears difficult for her to wait. As a sign of this impatience, she calls for Mrs. Jensen's help. Mrs. Jensen remembers from a choice of five to six paintings which one Sasha wants to finish. The advantages of being able to read are clear in this instance as Kyla points out the correct menu box. In the midst of helping the two pupils with the computer, Mrs. Jensen is asked for her approval of something another child has completed. She takes interruptions smoothly. Meanwhile, the child working alone, Noel, is involved in painting and is carefully and slowly filling her figure with colour.

Sasha and Kyla are working cooperatively on Sasha's painting, with Kyla operating the action key and Sasha manipulating the trackball. This kind of work appears to generate mistakes, enjoyment, and considerable communication: "Oops! (giggle) Now let go of the action key...Now press it." Although it is not obvious on the screen, what follows is an impressive display of erasing techniques using the background colour to paint over the mistakes. Again the girls work in tandem, initial mistakes leading to exploration.

The Grade 1/2 teacher

Mrs. Lakefield has been teaching at the primary level for approximately 14 years, the last 4 of which she has taught at this school. Her teaching, strongly influenced by her experience

with British educators and the reading of Piaget, involves strategies and materials that are effective at the primary level and address problems of how children learn.

Mrs. Lakefield, who enjoys planning and sharing with other staff members and has worked with other primary teachers in developing thematic units, says that the needs of the kids in the school go beyond simple teaching. "I give 'motherly' attention in an instructive way," she comments. She links her notion of "motherly" teaching to a belief in incidental learning which is why she uses what she sees as an informal teaching style. She believes that education should be geared to the individual child and that one's teaching should reflect this notion, and that children should have choice in learning. However, class size, a split grade, and time constraints often inhibit her ability to teach in the way she would like.

She uses a variety of grouping methods throughout the year, whole and small group as well as individual activities, in which children are given a choice of activities in completing theme study work. She uses a large number and variety of materials, especially in the language arts area, and her room is full of materials of every kind as indicated in the diagram of her classroom (see figure 5).

Although the children are withdrawn for music, Mrs. Lakefield believes music is a vital part of the language program. She integrates mathematics and science into an overall scheme; currently the class is working on a unit on trains, in which science, mathematics, language arts, and the arts are brought together. Although she does focus on certain areas within the unit she says, "It is the theme that provides the glue to learning." Most of the time she develops her own learning activities.

Mrs. Lakefield, who has no experience with computers, has some concerns about her involvement in the project, including its cost. She said that although the great expense cannot

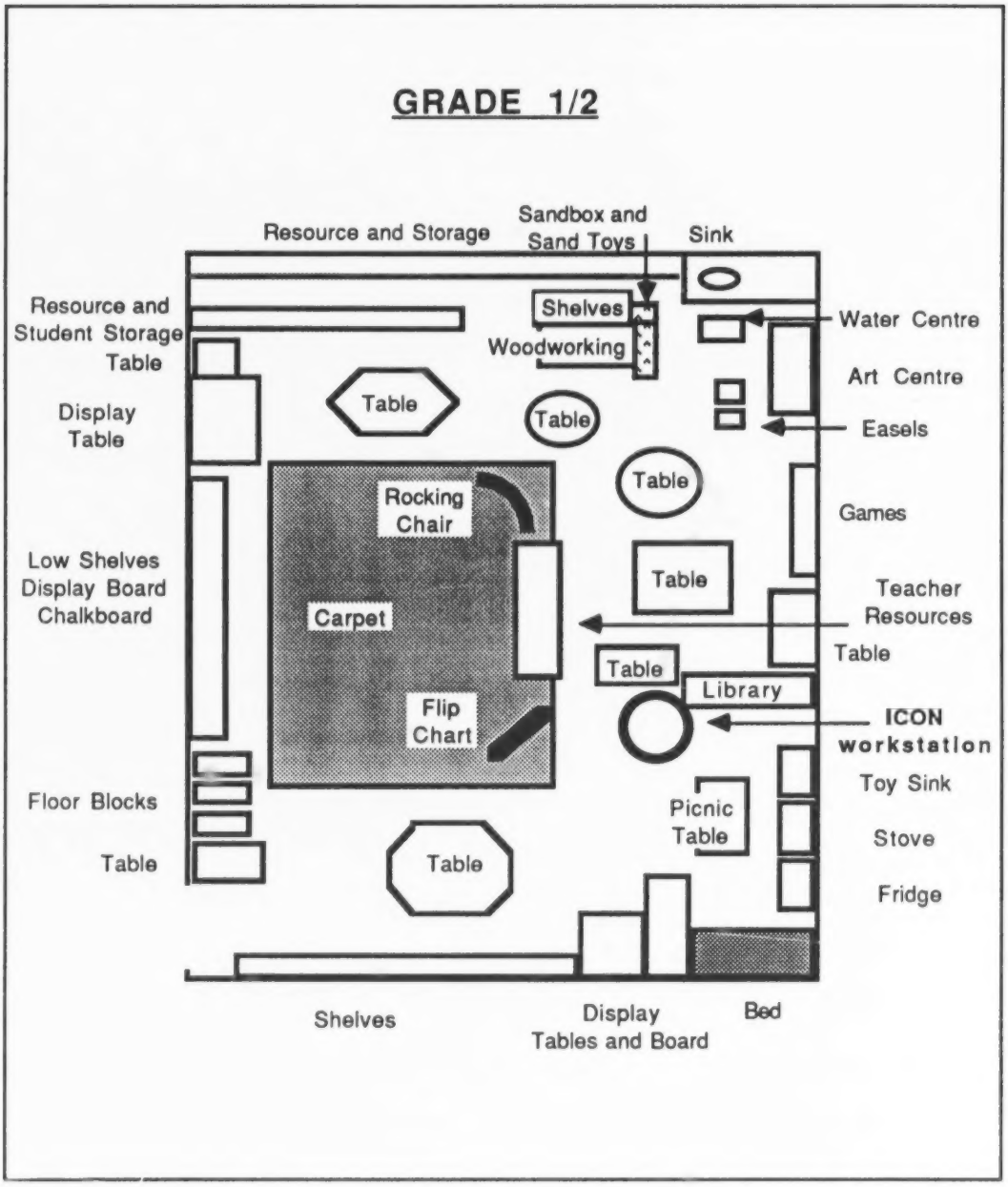

Figure 5. Grade 1/2

be justified and that the money could be spent more wisely on other materials, such as books and concrete learning materials, she is willing to learn how to use the computer in her classroom mainly because her students are keen, and she can not pass up the opportunity to make use of this source of motivation. "All children have different learning styles and perhaps the computer might serve a particular style," she argues.

The Grade 1/2 class

The classroom is packed with a multitude of materials and learning resources. The centres include sand, painting, a library, a computer, woodworking, boxes for sculpture, housekeeping, crafts, dress-up, puppets, floor blocks, water, easel painting, and small construction toys. Each grouping of work tables is equipped with pencils, markers, erasers, coloured pencils, and crayons.

It is 9:30 Wednesday morning, and the children are gathered together on the rug quietly visiting as Mrs. Lakefield and the student teacher, Lana, gather the necessary materials to demonstrate two new art activities based on their present train theme. The children are restless after participating in a 20- minute language discussion also conducted in the rug area. Mrs. Lakefield quickly senses their need for some physical activity. "Why don't you all stand up and do a big stretch?" she asks. Lana adds, "High as you can. As small as you can." The children gladly participate.

"No, I'm doing the splits," pipes up an eager voice. The stretching continues a few minutes longer, eliciting many smiles, giggles, and imaginative responses ending with "and sit down as quiet as mice" to which they respond quickly and willingly with one or two "shushes" by the children themselves.

The "ooohs and aaahhs" elicited by a sample finished product of the first activity attest to the children's enthusiasm, which helps account for their degree of attentiveness during the procedural explanation. Although the art activities are mainly displayed by Lana, Mrs. Lakefield often interjects in a soft-spoken manner whenever she believes clarification or information will be needed by the students. She also helps hold up the different materials for easier visibility, creating a relaxed team-teaching style.

After the second art activity is introduced, the children are given the choice of beginning one of the art activities or working on one of the language activities started the previous day. With only a quick reminder of the number limit at each station the children readily make their choices, and all are immersed in their activities in a surprisingly short time. This is a routine to which they are accustomed. The variety, number, and high interest level of all the possible choices is so great that no complaints about not being able to find a desirable activity are heard. Mrs. Lakefield and Laura are involved throughout the room, assisting the students when needed and providing encouragement and much praise.

Later, during the work period at the art table, Luke, Janice, and Leslie are gluing their tissue paper shapes onto the background. At first there is little conversation as their quiet faces show a consuming interest in the chosen task.

"I invented grey!" exclaims Luke.

"Pardon?" Janice asks as she leans over to take a quick look.

"I just invented grey - yellow and green. I invented quite a different grey!" claims Luke excitedly.

"I know that," Leslie states in a matter-of-fact tone as she reaches for another piece of tissue paper with an intense expression on her face as she concentrates on her own creation.

Mrs. Lakefield raises her voice to be heard over the busy chatter. "You have three minutes and then you are going to have to leave your things where they are and get your library books and get ready for library," she says. "Three minutes."

"Yuck!" exclaims Janice with a disgusted look as she manages to get glue on her fingers. Luke, Janice, and Leslie continue to work intently on their train pictures with no visible reaction to Mrs. Lakefield's time warning.

At another work area, a table around which most of the girls typically gather, Hayley and Cathy are sitting intimately together. Two Wrinkles dogs are perched on the table immediately in front of them. With their chairs touching and heads close, they examine with giggles and smiles the language activity they have chosen.

"Let's first start with this, T-U-N-N-E-L," says Cathy, taking the lead.

"What's that spell?" asks Hayley with a quizzical look on her face.

"Tomato," determines Cathy.

This prompts several giggles. Hayley looks often at Cathy's paper, relying heavily on her support.

"What?" Hayley asks, shaking her head, as Cathy explains part of the instructions.

"Colour red", Cathy repeats in her "teacher role," keeping close physical contact with Hayley and readily providing leadership.

"All right people and stop," says Mrs. Lakefield. As her mouth drops open and her nose twists up, Hayley's expressive face shows her disgust at having to end her activity. Her hand gently slaps the table, but she responds to Mrs. Lakefield's request, signing her worksheet, placing it in her train folder, and readying herself for library time. Mrs. Lakefield continues, "Just tidy up your work where you're sitting. Don't put it away. Tidy up where you're sitting. Push your chairs in. Go and get your library books, your cards, and go to the library."

After recess, as the students are settling onto the rug area, Mrs. Lakefield is questioned by several children as to who can go to the computer lab that day. Janice is included in the computer group, and her reaction is to give a small leap for joy. Mathew, however, is not chosen, and he hits his fist on the rug in frustration. Mrs. Lakefield attempts to control their eagerness to get to the lab by saying, "It's not time to go to the computers yet, and you may not take someone else's place. If a person is away we'll leave one computer empty, simply because it's too hard for me to keep track of where people are supposed to be and when. It's very confusing because you tell me one thing and I can't remember. The other part of the class will be coming to gym with me." "Yeah!" several whisper in response. "And tomorrow, the part that went to the gym will be going to the computers. We'll flip-flop."

"YEAH! - OH GOODY!" and several other excited responses are more loudly voiced. Colin and other nearby boys smack their hands together in approval, smiles spread across their pleased faces. Mrs. Lakefield settles the children again, and then explains what will happen next. "The rule is this," she says, "You may go to something else, another train activity, if you have finished the previous train activity you started before recess. If you haven't finished it,

then you must continue to work on that. We are going to take another 10 minutes, anyway. We're going to introduce all the train math activities."

The Grade 2/3 teacher

Miss Carson, who has taught for 1- years, 4 at this particular school, has been continuously involved in professional development through Ministry of Education Primary Specialist, Social Environmental Studies Part 1, and Visual Arts Parts 1 and 2. She informally collaborates with a number of staff members and has set up working relations for her students with other classes (i.e., reading buddies with the Kindergarten children and music partners with the special needs students).

Miss Carson spends approximately 20% of her time teaching formally, with most of her preparation time spent in preparing materials and activities to address the needs that she has identified. She comments on how her role as teacher has changed by stating, "I don't feel I'm the teacher anymore, I'm the supervisor.... Teachers have to be willing to give up the role where they have all the answers."

Her goal is first to "produce self-confident children–and then the other educational goals–social and emotional–will follow a lot more easily." Miss Carson offers children freedom within a logically sequenced environment, which must be flexible and enriching, with social interaction a key factor in learning. This is particularly true in using the computer, which produces "a lot of sharing of ideas and discoveries and creations [which are made] together."

She uses learning centres a great deal. Students sometimes circulate systematically and at other times choose a centre. She does not use workbooks or worksheets and only occasionally uses a mathematics text. She makes most of her own materials.

Miss Carson has two ICONs, an Apple //e and a Commodore 64 in her room. While children have almost constant access to the machines, they have 30 minutes of free choice, when their name comes up on the rotating schedule. Mostly, they pick a partner and work in pairs.

Miss Carson said children tire quickly of drill programs and that she prefers to use software that promotes creative thinking like problem-solving games, for example Lemonade Stand, a program for the Apple //e. She thinks that children's logical thinking is influenced by the use of computers, for example, when they follow logical steps in entering programs or going through programs such as Math Maze or Logo. She does not integrate computers into her program, partly because she has not found any ready-made programs that apply to the curriculum.

The Grade 2/3 class

The school day begins with 45 minutes of activity time. The children can choose individual activities, play checkers, play in the sandbox, read, draw, or work on one of the three computers (see figure 6). Miss Carson circulates around the room during this time, offering assistance and comments. Students appear to work well with one another, taking an interest in others' activities, or working cooperatively at group activities such as building water volcanoes at the sandbox.

Following the various activities, the children have story writing time. Each student pulls out his or her story folder containing current stories and pictures. Many of the folders are quite personalized, with a variety of stories, pictures, and designs.

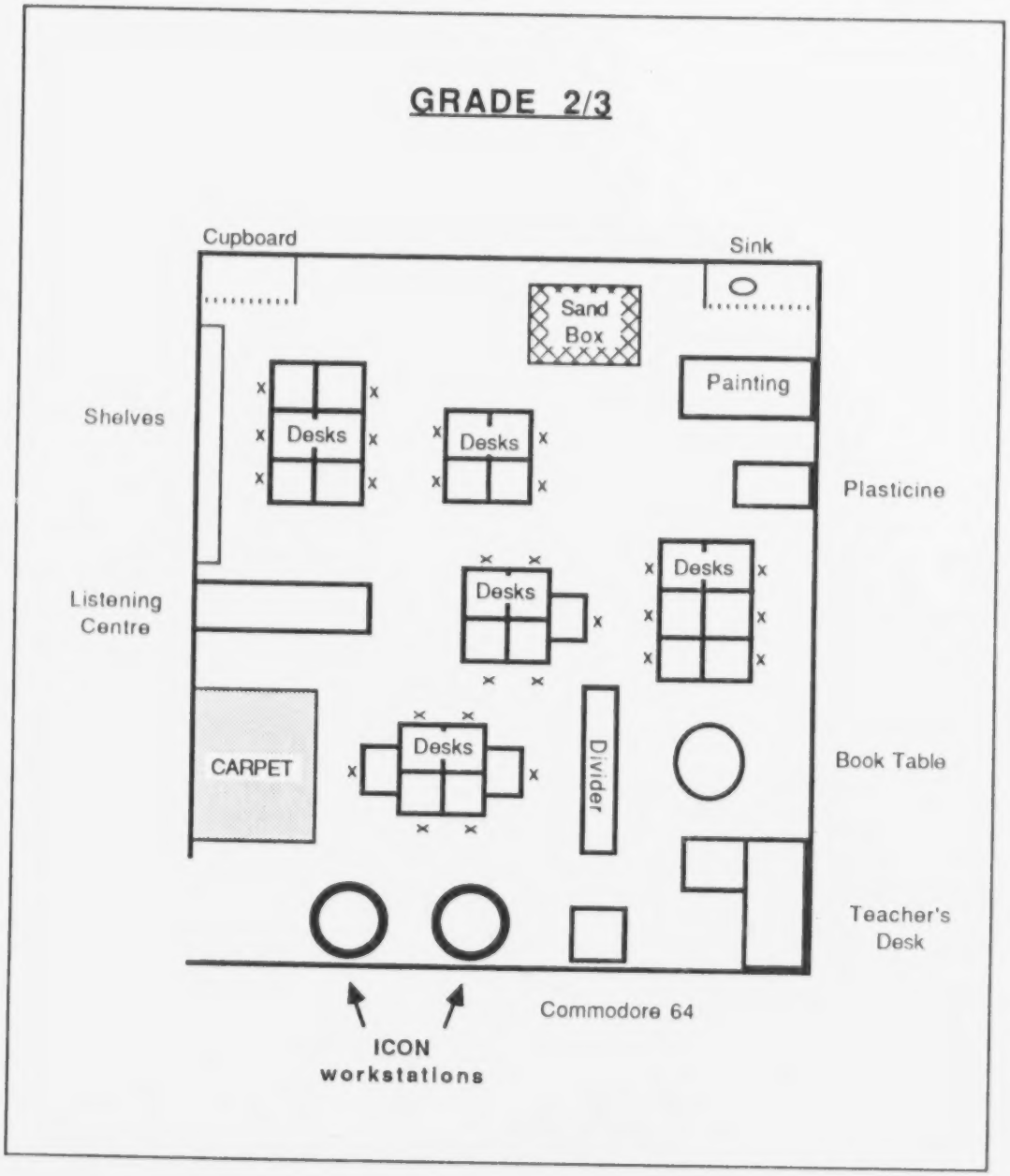

Figure 6. Grade 2/3

At the set of desks closest to the computer terminals, three girls sit working in their story folders. One of the girls, Angie, is receiving some suggestions from the teacher on the story that she is composing today. Behind her, several students are using the computers. The computer activities appear to be quite intriguing, based on the enthusiastic comments coming from the children. "Wow! Take a look at this!" says one boy, turning to a classmate at the terminal behind. He not only grabs the attention of his friend, but also draws a curious glance from Angie, one of the girls at a nearby desk. She turns from her work for a moment to view the computer program before returning her attention to the story.

The computer activity continues in the background. A few boys working at the terminals are discussing the procedure for changing to a different program. "It's right beside Logo! Right beside Logo on the left!" says one. Angie gets up to retrieve a stapler from the shelf and comes back to her seat. She pauses to investigate the happenings behind her, and then turns to the task of stapling the pages of the story together.

Much to Angie's dismay, the stapler is not working. To her rescue comes a classmate at the next desk, who quickly discovers that the stapler is missing one key ingredient - staples. Off goes the friend to find more of the needed staples while Angie sits and waits patiently for her return. Again, Angie's attention is drawn momentarily towards the activity at the computers.

Returning to her desk with stapler and staples in hand, the friend now attempts to insert the staples, but it still will not work. At that moment, Miss Carson approaches the area, and the children ask her to examine the defective device. As she stands at the desk performing the necessary surgery, other children begin to gather around. One girl shows her a completed picture. A boy has a question to ask. One girl joins in just to investigate what the teacher is

doing. "Miss Carson, look at this!" says another boy, holding out an object and joining the group.

Miss Carson's classroom appears to be a caring and compassionate environment. Angie was instructed in a positive, encouraging fashion to re-focus on her writing. Angie's neighbour was willing to assist with the stapler, going to get the teacher herself rather than handing the problem back to Angie. This exemplifies the different types of personalities that exist in this classroom, from the actively curious to those who are able to intensively focus on an activity or problem and follow through to the best of their abilities, such as Angie's friend.

The Junior Division

The Grade 3/4 teacher

Mr. O'Malley has been teaching at this school for 16 years. In his 20 years of teaching he has taught all of the elementary grades and has also taught at the high-school level. He is active in several education councils in the board: the Physical Education Council, the Computer Council, and the Public School Teachers' Federation.

Mr. O'Malley prefers to work independently, although he is willing to help others. He sees himself as the one who motivates and initiates within the classroom. He comments, "It's my job to take all of the kids in the classroom just as far as they can go and to challenge them beyond just the regular things that they would do and to build up their own self-concept so that it is very, very positive and if you do those things then everything else is going to come along." He stresses the importance of encouraging children to become creative and independent as well as helping them to develop a good self-image.

Mr. O'Malley thinks that the materials with which the students are to interact should have a specific focus: "Children have to know what the guidelines and parameters are and that these structures are consistent." He pre-tests and then programs according to the student's needs. He suggests that much learning occurs through social interaction within the classroom and through interaction with the environment: "The environment is key. It has to be a happy, inviting, safe, and adaptable place."

In mathematics and language, he uses no class texts but many individual texts, workbooks with different readers, and worksheets. He has a complete printing press in his classroom and his students publish books, and print and sell greeting cards.

He is greatly interested in computers in the classroom, and was the staff member who encouraged the school's involvement in the project and who wrote the application. He has been heavily involved with all aspects of the setting up and the first phase of introducing the computers into the school. He has concerns about the limitations of Ambience and the lack of appropriate software. He also feels that the available software is not sufficiently flexible.

Mr. O'Malley has three computers in his class, "I look at it as a tool that has an awful lot of possibility. It can do an awful lot of things with the students that I can't do when I can't get to them, and it allows for a lot more creativity with some of them than I have the creativity to help them with."

The Grade 3/4 class

For the first 35 minutes of the afternoon, the Grade 4 class is out of the room at French. Mr. O'Malley starts this period with a math bee for the Grade 3 class. He has a set of over sized

dice with numbers and mathematical operations on the sides. He rolls the dice, calling out the resulting problem. Two students stand and try to answer the question. If someone answers the problem correctly, he or she remains standing and competes against the next student in turn. Competition is keen, and when the competing pair are slow to answer, the others find it difficult to contain themselves. The game continues for about 10 minutes.

Mr. O'Malley announces, "I'm going to give you a puzzle." "Oh, yeah!" the class replies enthusiastically. The puzzle consists of a star shaped diagram with circles at the six vertices and at the six points where lines cross. These circles are to be filled with the numbers from 5 to 16, each number to be used only once, in such a way as to make the sum of the four numbers along each straight line be 42.

The five is set in place at the top point of the star. This is a difficult puzzle for children of this age. Mr. O'Malley passes out copies of the puzzle diagram to everybody, and draws one on the blackboard for preliminary work. He asks the class what number to put in one of the circles next to the five. Peter suggests 16. He lets Peter choose two more numbers, 10 and 11, to fill in the rest of that line. When Mr. O'Malley confirms that the numbers Peter has chosen do indeed add up to 42, everyone starts to copy that line onto their diagrams. Mr. O'Malley warns them that this is premature, and that they should do everything lightly in case it has to be erased later.

Someone suggests six for the spot marked by "?", and Pat, who often has difficulty in mathematics, says, "No way!" Mr. O'Malley replies, "Why did you say no way, Pat?", but Pat can't give an answer. Then Mr. O'Malley points out that 9+16+6=31, so the 11 would be needed to make 42, and the 11 has already been used. "So Pat was right when he said 'No way'."

After a few tries at filling in the remaining positions, it becomes clear that this will not work. Mr. O'Malley says, "We're stuck right at the moment" and one student asks, "Can it work?"

"Oh yes. You might have to end up erasing all of it".

This comment is met by a general groan. Rorry asks, "Do we have to use just those numbers?" and Mr. O'Malley assures him that the rule is correct.

At this point, after about 10 minutes of general class work on the problem, Mr. O'Malley says they can split up into groups and work on the problem independently. Usually when this happens, the groups are allowed to move to any part of the classroom, but because of the power cable for the camcorder, Mr. O'Malley asks the students to stay in the front part of the classroom (see figure 7). Five groups form: six boys make a circle on the floor in front of the table (this group later splits into groups of four and two); two girls work at their desks (later moving to the blackboard); one boy girl combination forms; and two students, who seem to have difficulty in mathematics, work together. The remaining girl works alone at her desk, despondent because of a fight she had with her friend.

Most of the children work diligently at the problem and their interest does not wane. After a while, Rorry asks what book the puzzle comes from. Mr. O'Malley answers that it is a big thick book belonging to Mrs. Monroe.

"We need to get that book here," Brian says. "Your chances of getting that book are pretty slim." Mr. O'Malley retorts.

Mr. O'Malley then calls the pupils back to their seats, telling them to work on the puzzle over the weekend. He mentions they could get help from their parents if they want, but he

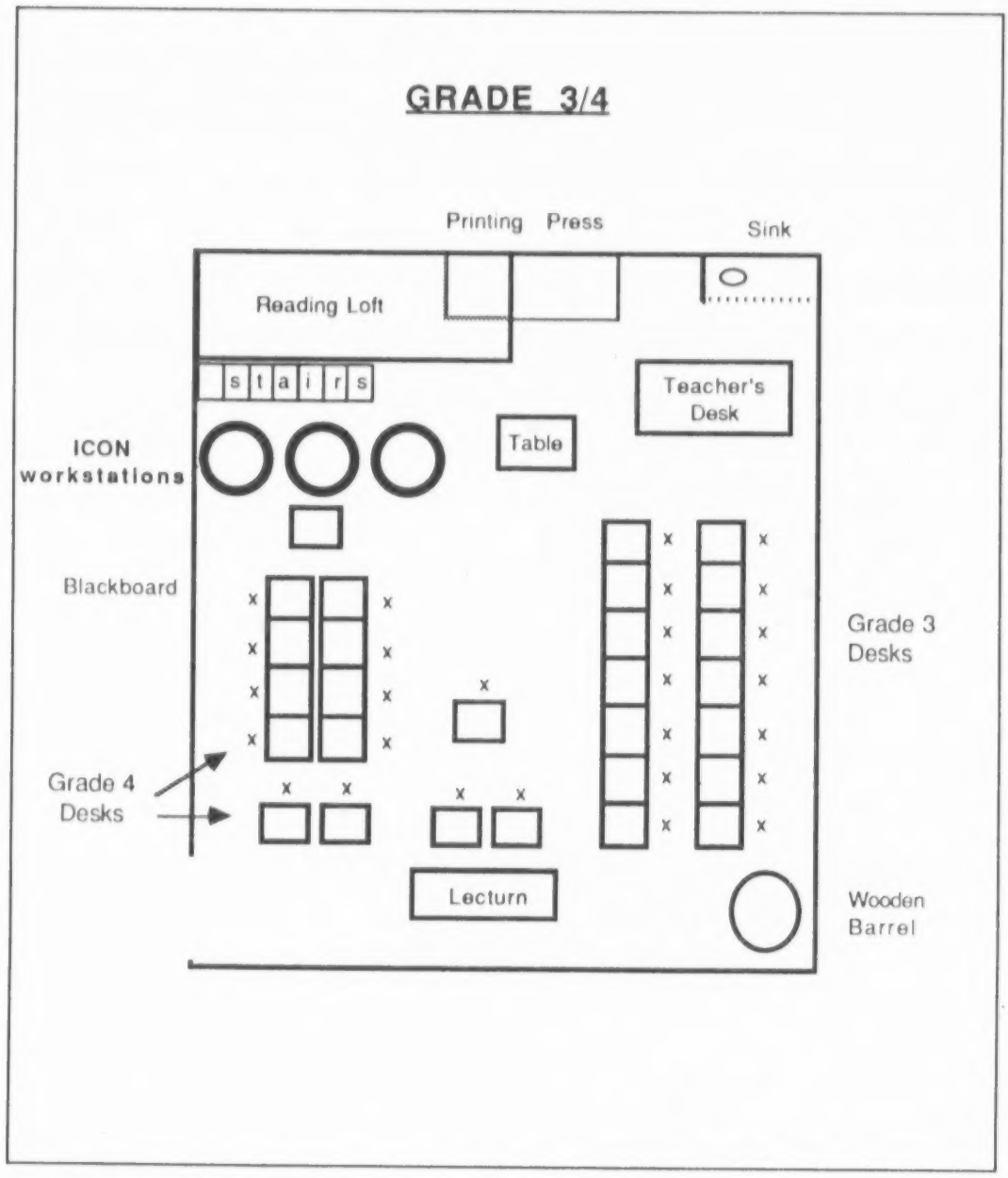

Figure 7. Grade 3/4

adds, "I don't want you going home and saying to your mom and dad 'Look, here's your homework. You've got to get it done!'" He gives them a hint that they might want to try using smaller numbers at the points of the star.

At this point, the Grade 4 students return from French class, and the Grade 3 students leave for their French lesson. Mr. O'Malley gives the Grade 4 class a word puzzle to solve, announcing that every Friday they would be given a puzzle of some kind, either math or language. After the students work on the word puzzle for about 10 minutes, they are split into two groups. Six of the students remain in their seats, working on a multiplication worksheet. The other eight go to the back of the classroom and sit in a circle with Mr. O'Malley beside his desk.

Mr. O'Malley explains the rules of the game. He has a double deck of cards from which all the face cards have been removed. Each student is given a stake of five blocks by Linda, who acts as the bank. The blocks are small interlocking cubes which the pupils use when practising multiplication. Taking each student in turn, Mr. O'Malley deals a single card face up. The student then wagers some or all of the five blocks, whereupon Mr. O'Malley deals a second card. If the student correctly multiplies the two numbers, Linda pays off the wager from the bank; otherwise, the wager is forfeited to the bank. A student who goes bankrupt is allowed to borrow from the bank, but the student has to pay interest to discharge the debt.

To start the game, Mr. O'Malley deals one card to each student. Tom draws the highest so is given the first turn. He is dealt a 3, bets one chip, draws a 5, and correctly answers 15, thus winning his bet. Next, Tasha receives an ace; Mr. O'Malley suggests that she might want to bet a higher amount than Tom, and Tasha hazards her entire stake. Mr. O'Malley says, "Ooh, if she's wrong she's lost them all." When Tasha successfully negotiates the calculation,

there are some comments from the others such as: "That was easy," and "Oh yeah, that's so hard, Tasha."

Renee draws a 9. She bets two chips, draws a second 9, and answers "81" in a flash. Mr. O'Malley says, "I think there's some people who wouldn't have gambled two on that one", getting two comments of "I would", and one of "I don't know if I would". Jesse then misses 7 times 8. Renee points out that this is 56, but when Linda, next in line, gets 8 times 7, she can't remember what Renee had said. Norm draws an ace, and lays down all of his blocks with panache, saying, "All of 'em," to which Mr. O'Malley responds, "Awesome!"

In the second round, Tasha is dealt 5 times 6, and says, "35....30." After paying up, she adds, "The five wasn't supposed to be there", earning a chuckle from Mr. O'Malley. Linda draws an 8 and bets a single chip. When she gets an ace, Mr. O'Malley says, "Oh, if you'd known there was an ace...." After Jill misses 9 times 8, Mr. O'Malley shows them a trick for the 9 times table, using the fingers of both hands.

The Grade 4/5 teacher

Mrs. Peters has been teaching for 16 years and has served as the president of the Women's Teachers' Association in Kingston. Describing her preferred teaching style as working alone independently, she sees her role as an organizer: "I like to know what's happening before it happens. I expect the kids to be as organized as I am--or almost. I like to know where children are, that is, what page they are on, where they are in the notebooks."

She emphasizes the importance of beginning where the students are: her first goal is to assess the children and discover their needs, which she does mainly through informal methods.

Children, she says, learn by example, through observing: "At this age kids mimic what they have seen." Consequently, she tries to be a good model. She sees the need for structure and consistency, noting how children like routine and adding, "If they are happy, I'm happy."

She tries to guide her students to discover for themselves how to do assignments and become independent.

Although she constantly changes the physical set up of her room she comments that, "The learning environment is very standardized.... I don't change a lot in terms of what I do with the kids."

Most of the work she does is text-based: she uses texts in mathematics (as well as some drills) and in language arts uses readers and labs as her main resources. Because students need to master the skills of reading, she uses labs because they focus on skills, are sequenced, and provide record-keeping provisions.

Mrs. Peters carries out a daily uninterrupted silent reading program (SQUIRT) and uses the new Frontenac County School Board writing folders with her class: "We try not to direct kids what to write, and it's hard not to."

Mrs. Peters has had some experience with Logo, but much of the computer-based learning is new to her. She is eager to learn herself and to introduce it to her class because Logo, for example, ties in nicely with her current geometry unit. She believes the children will learn more about angles and lines from Logo than from a text.

Now that Mrs. Peters has a computer set up in her classroom she has organized a rotating schedule which allows the children to have 10 minutes of free time on the computer. Mrs.

Peters is currently taking Computers in the Classroom, Part I from the board computer consultant.

The Grade 4/5 class

It is first thing Wednesday morning. The class is engaged in silent reading: the teacher is reading at her desk and the children are quietly reading at theirs, which are in rows along each side of the room facing towards the centre (see figure 8). Leslie, who is at the computer because it is her turn, looks around for assistance and a girl from half way across the room, with book in hand, runs to the computer and presses the keys necessary to log on and bring up the program menu. She returns to her desk quickly. Leslie looks at the screen, presses a few keys, then turns for assistance to a girl who is close to the computer and who remains at her desk but looks at the computer screen, whispers a few suggestions, and turns back to her book, trying not to allow herself to be distracted from her reading. Within a few seconds though, she is looking at the computer screen again, slightly interested in the problem but not having too many solutions. The rest of the class is concentrating on their reading, ignoring Leslie at the computer.

Leslie, using the Putting Yourself Together program, is making a face using the trackball and action key. She says this is one of her favourite programs.

The class continues reading silently for 10 minutes and Leslie continues to use the Putting Yourself Together program. It is spelling time now, and the class goes in groups of three to the teacher's desk with their spelling work. Mrs. Peters checks this with little comment and within half a minute each child returns to his or her desk to write.

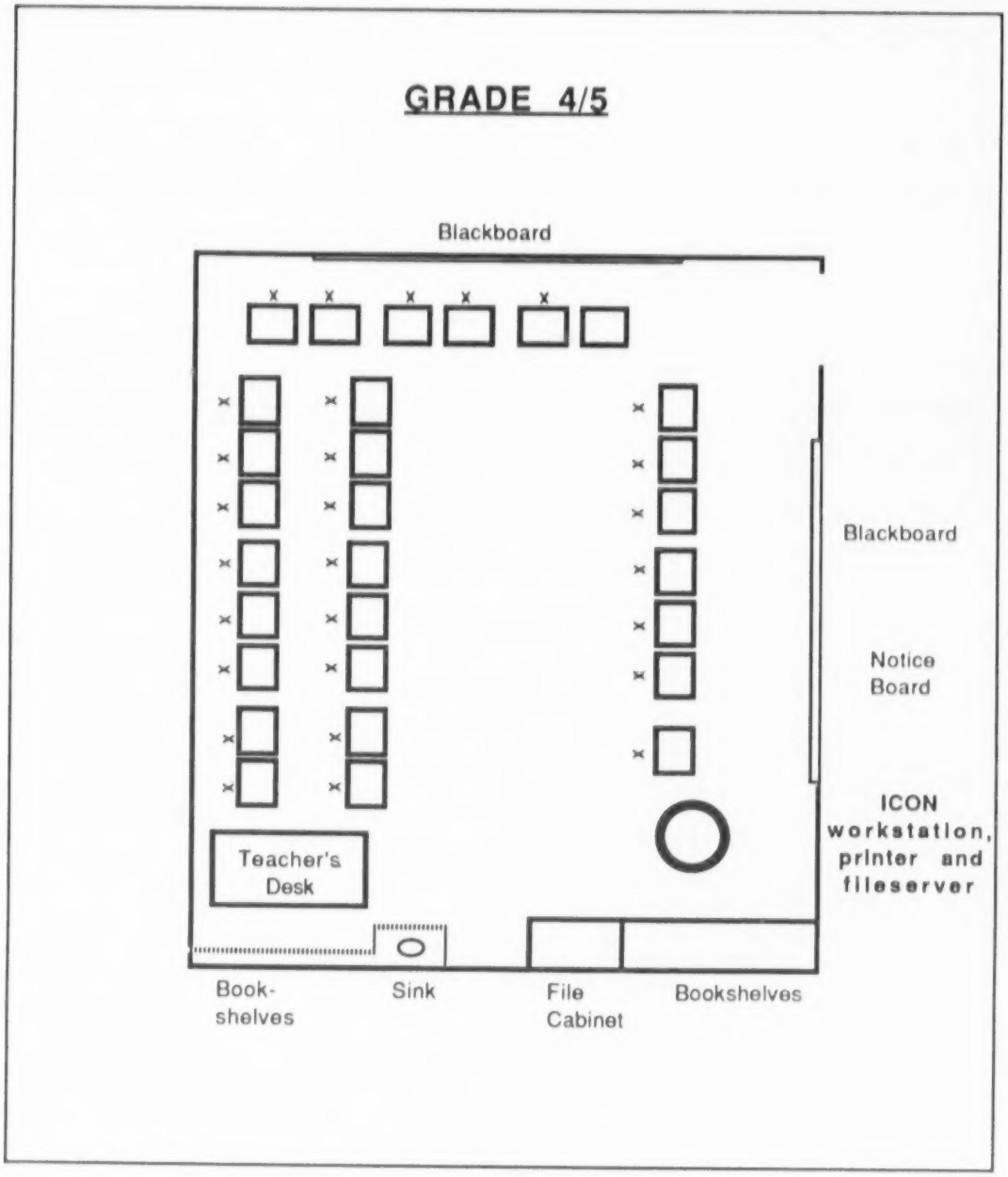

Figure 8. Grade 4/5

After Leslie two other girls use the computer: Sarah and Erin. Erin presses the keys and Sarah watches. They frequently take turns in watching and using the keyboard and Erin often says, "It's my turn," and Erin gives way. The girl at the desk nearest the computer is watching what the other girls do and making the odd comment.

The Grade 5s line up to leave the room for French, while the Grade 4s are going to the library. After the class leaves Larry Miller comes in to interview Mrs. Peters. They sit down to talk, and the two girls at the computer start to giggle together and whisper. On the screen they are making circles, squares, triangles. "It's my turn," says Erin and she takes over, presses a few keys, then when she sees what appears on the screen says, "I don't want it that way." They giggle again and make diagonal lines appear all over the screen. They take turns pressing the keys. Sarah logs off, and they leave the room.

The Grade 5/6 teacher

Mr. Rawley is an experienced teacher having taught in many Ontario schools as well as overseas. He has team-taught units with another teacher in the school, but most of the time he favours an independent working style, encouraging and motivating students.

"Everyone has something to contribute and should feel that they can," Mr. Rawley contends. He wants to build student self-confidence, and feels the computer can make a large contribution here as well as in motivating students. He wants to "provide an environment that's interesting and non-threatening." Freedom, he suggests, must be within a logically sequenced environment: "It's not license, but it's freedom."

In the past four years he has used the Socratic method, not using centres as much as he previously did. He varies his teaching style through the year, starting with fairly structured teacher oriented learning situations involving a great deal of review of basic skills such as spelling, punctuation, and arithmetic facts. He then progresses to study groups and centre activity with a greater degree of student interaction.

With the changes in teaching style have come changes in the learning process. He starts by transferring knowledge from teacher to students, and later learning takes place more through social interaction. He is confident that when the students move through learning centres they will not have problems with spelling, grammar or tables, because he knows that they have covered these through the lessons he teaches in the first half of the year. At the beginning of the year the room is arranged in rows, and in the second half of the year it is arranged in groups.

Mr. Rawley uses mathematics textbooks in Grades 5 and 6. Children work independently at their books and he works with individuals who are having trouble. He also uses commercially available workbooks and worksheets a great deal in all areas. He enjoys teaching reading and comprehension, discussing in small groups what they have been reading to see how they have been gaining insights, and reads daily to the class--just for the pleasure. He finds that the students enjoy his dramatic reading.

At first he was not enthusiastic about computers when there was only one in the school, but "It's different now I have one in my classroom ... I think the computer is an exciting thing the way it is in this school--there's enough of them to go around." He is particularly keen on having a bank of computers in the computer room, saying "It is beautiful... 15 computers with 30 kids, 2 at a computer... they will get a chance to talk to their partner."

The Grade 5/6 class

Following morning recess at 10:30 the Grade 5 students go to French class for 30 minutes while the Grade 6 students go to their desks for mathematics (see figure 9). Mr. Rawley writes a question on the blackboard and explains, "This is a two-step question. A pair of skis originally priced at $225 are on sale at 22% discount. How much will they cost with a 7% tax added to the new price? So you have to find two things. What do you find first?" Hands go up and students give the answer. "New price first," says Mr. Rawley. "And then what do you do?" "Put the tax on top," say a number of students in unison. "First you have to find out what the discount is and what the tax is going to be". "GO!" says Mr. Rawley. The class sets to work with pencil and paper.

After a few minutes Mr. Rawley asks, "How many people ski?" People put up their hands. "I hear someone say that would be a cheap pair of skis." "Yes, it is," they respond. Mr. Rawley walks from desk to desk, helping students individually.

At the front of the room he asks, "How do you write 22%?" Students put up their hands and tell him, "Twenty-two over a hundred." He writes it on the board--22/100. "What's another way? Dana?" A girl says, "A decimal--.22 x 225." Mr. Rawley writes it on the board and asks, "How many did it this way? How many did it this way?" Hands go up. "How many got $49.50? You can double check by doing it both ways."

The lesson continues in this way, with Mr. Rawley questioning the students in stages in a similar way to work out the tax. The students respond by putting up their hands or just saying the answer. There is an atmosphere of give and take: a bantering back and forth.

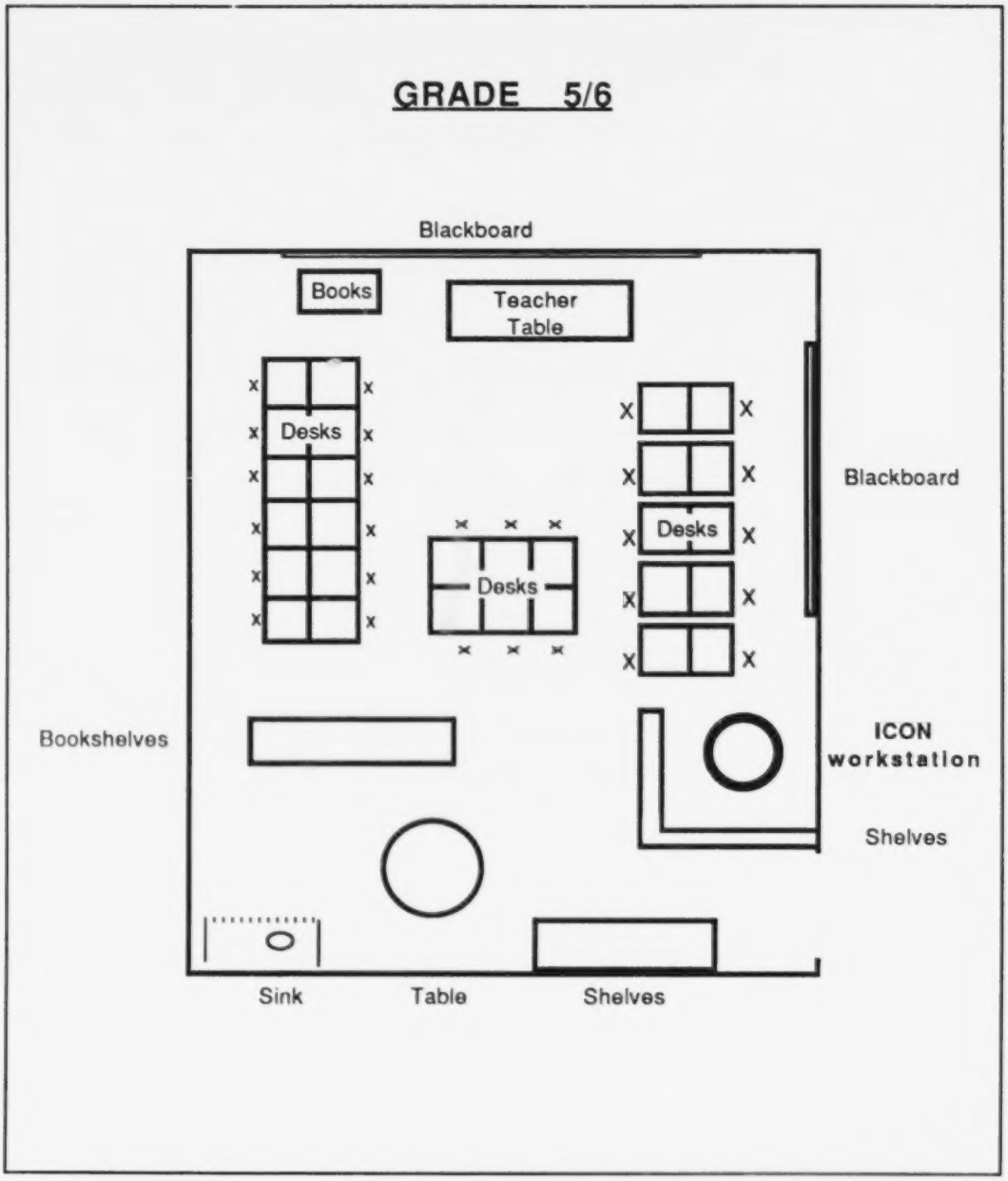

Figure 9. Grade 5/6

"This time I'm not going to help you work in stages; we want your final answer. You can give me the amounts. You people know more about the price of skis than I do. So I want to buy a fairly good pair of skis, Karen?" Karen says, "$700."

After some time Mr. Rawley goes to the front of the class and works out the question in stages with the students. The students come up to the board to work out parts of the question. The children refer to Mr. Rawley affectionately as "Mr. R.".

When the Grade 5 students return from French the Grade 6 students leave for French. It is the Grade 5 spelling time. "Are the girls going to beat the boys this morning?" challenges Mr. Rawley. The class is divided according to sex, three girls on one side of the room and seven boys on the other. Mr. Rawley asks each side alternately to spell a word and if they are wrong the other team has a chance to spell it correctly. Students have to listen to how the word is spelled. This moves along at a fast pace: "That's it, the boys won, go back to your seats."

Following lunch the class goes to the computer centre, where students sit on the floor in a circle while Mr. Rawley talks about a science experiment they did concerning convection currents. He goes over the details of the experiment involving heated water and coloured ink, constantly questioning the students about what they saw. He talks about the relationship of their experiment to wind and weather systems, and how the sun heats the surface of the earth. After the discussion the class prepares a report of the experiment using the Story Mate program, working in pairs, talking to each other, and seeking help from Mr. Rawley and from each other. Considerable help is needed--for example, how to spell "convection" or "demonstrate", and what format to use for the report. Two girls have trouble getting started. They don't know how and where to put the title "convection", and they ask Mr. Rawley for help, but he is busy talking to other students, so another child helps them. "That doesn't look right," says one girl "Too many oooos." They walk over to ask Mr. Rawley how to spell

"procedure". He comes back with them. "Purpose comes first. Write in purpose, colon," he says. "What's a colon? Oh, here it is."

Specialized Support Staff

The Special Needs Teacher

Mrs. Jones, who is in her first year at this school, has been teaching for 4.5 years. She has taken the Ministry of Education Specialist in Special Education and has been involved with handicapped children for the last 3 years in other educational settings.

Mrs. Jones prefers collaboration; for example, she has arranged with Miss Carson for her students to work with children in Grade 2/3. Due to the structure and the needs of her class, she finds collaboration with other staff members difficult.

She sees her task as helping children develop functional skills (including early communication skills) and promoting positive attitudes to disabled people within the school community. She wants students to be able to initiate interaction with other persons in an appropriate manner, and to communicate by gesture, vocally, or through pictures.

Developing these abilities requires highly motivating materials which must often be adapted to the unique needs of the individual, accordingly, all of her students are on one-to-one individual programs. Because the special adaptation of materials is often difficult, time consuming, and expensive, she hopes that computer-assisted devices may prove to be useful.

Self-esteem, she believes, develops when an individual can exercise control over his/her physical and social world, when students have the tools they need to discover answers on their own, to think creatively, and to solve problems. Learning occurs incidentally, she says, when

students are so interested in what they are doing that they put their energy into it. In the process the teacher acts as facilitator and structures the environment so that students can form their own conclusions. She says her teaching style is radical, often involving practices not normally expected in the classroom, due to the physical intensity of the job.

She uses music as the basis of many interactive games: "Music is highly motivating for almost all of the kids."

One of Mrs. Jones' aims is to have the handicapped children interact with non handicapped peers through computer activity. She says that the computer has potential as a highly motivating tool. She hopes that with the development of special needs adaptations, her students will have access to computers and appropriate software so they will have more control over their environment. She remarks, "Trying to find creative means to allow very severely physically disabled people to communicate effectively and therefore have some control is a great and exciting challenge." She thinks that the computer may help her to meet this challenge.

The Special Needs Classroom

The special needs classroom is home to Mrs. Jones, her teaching assistant, and the students: Murray, Alyson, Janet, Cameron and John. It contains a variety of specialized equipment to meet each individual's physical and developmental needs (see figure 10).

A weekly schedule is posted in the room showing activities that take place at set times during the week, including three visits from a physiotherapist, bi-weekly theraputic swims on Tuesday and Thursday afternoons, and Thursday morning visits from Grade 2/3 students.

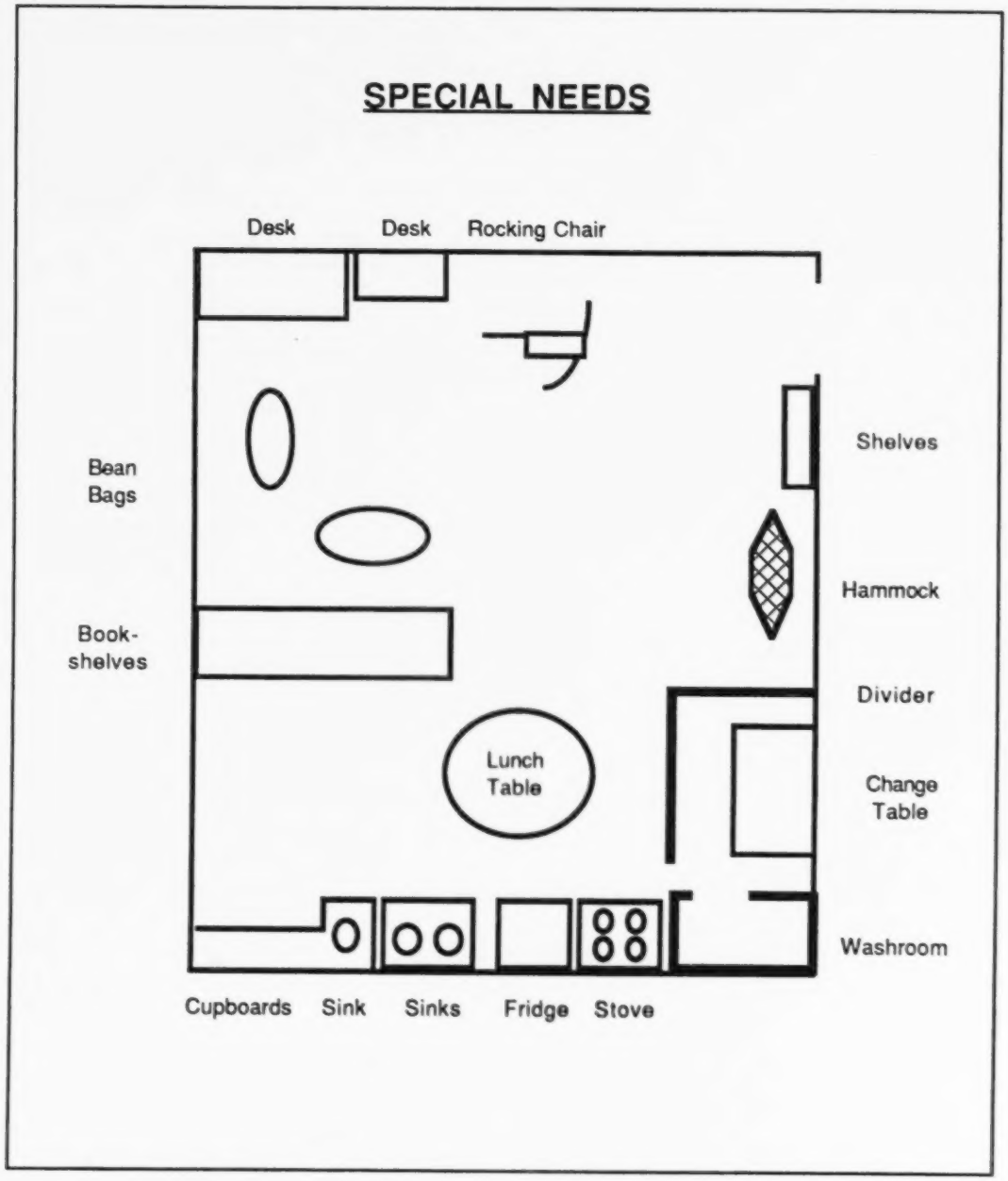

Figure 10. Special Needs Classroom

Lunch is at 11:00 each day and the class ends early, at 2:30, in order to prepare everyone for the journey home. Outside the classroom door is a weekly sheet for students to sign up to take one of the special needs students for wheelchair walks around the halls at recess, or in the warmer weather, outside.

After 10:30 the children come back from morning recess break. It is obvious that the students in the special needs class and the students who come to take them for recess walks are the best of pals. Their greetings are warm and enthusiastic: "Hi Murray! How are you today?" They include physical contact, such as a lingering touch on the shoulder or arm, or a rub of a hand over a hand. Julie, a Grade 6 student, and Cameron's recess escort today, is especially fond of her special needs friend. On days when Cameron is absent from school, Julie is disappointed, commenting on Cameron's absence in a dejected tone of voice.

Most class activities require one-to-one interaction between student and teacher, or one of the non-teaching assistants in the room. After recess Mrs. Jones works with Cameron who is 12 years old. He is not able to walk, has limited use of all limbs, and is not able to speak, but is learning to communicate through various body signals and recognition of pictures and symbols.

Mrs. Jones places Cameron into a special molded seat, much like an infant's car seat, which is strapped onto a rocking chair. She sits directly in front of Cameron and shows him a photograph of the rocking chair and asks if he wants to rock. He answers "yes" by swinging his foot. As she rocks Cameron, Mrs. Jones sings improvised songs made up of familiar melodies and lyrics related to the activity.

"This is the way we rock the chair,
Rock the chair, rock the chair,
This is the way we rock the chair,
On Thursday morning at school.

This is the way we rock the chair,
Rock the chair, rock the chair,
This is the way we rock the chair,
And this is how we STOP."

On the word "STOP", Mrs. Jones gently slaps her hands down on the arms of the chair in time with the lyrics. The rocking ceases. There is a moment of silence. "I can't hear you. What do you want?" asks Mrs. Jones. Cameron's right foot begins to swing back and forth. "Oh, I see that foot kicking!" She says, holding up the photograph of the rocking chair for Cameron to see. "You want to rock in the chair!" The rocking begins again, this time with a new song.

"Rockety - rockety - rock,
Rockety - rockety - rock,
Rockety - rock, rockety - rock,
Rockety - rockety - rock."

This verse is immediately followed by another song.

Mrs. Jones makes the American Sign Language sign for "finished." "Finished? Finished?" she asks Cameron. "Let me see what you would like to do next." She gets up and returns with two more photographs. "You know what we need? Kleenex. Just a second." Getting up again and returning with the tissue, she wipes Cameron's mouth and puts the used tissue in her pocket. "There!" The activity continues.

Holding up the two new photographs Mrs. Jones asks, "Would you like to go in the beanbag chair or play with the toys?" Cameron coos and smiles. "Toys or beanbag?" she asks again, drawing attention to the pictures by moving them gently in front of his face. Cameron rolls back his head, coos, and taps his hand on his leg. "Toys or beanbag? Cameron! Cameron!" Mrs. Jones is calm, but persistent. "Toys or beanbag? Not interested in either? Try one more time. Toys or beanbag?"

Cameron's only response is to roll his head back and tap on his leg. "You sound bored!" exclaims Mrs. Jones. "Toys or beanbag? No thanks! No thanks! Well, it's time for lunch, so how about we just get you into your wheelchair, O.K.?"

Later, Mrs. Jones explains what happened in the session with Cameron. The rocking takes place while a song is in progress as long as Cameron maintains eye contact with her. If eye contact is lost, the singing and rocking cease until eye contact is re-established. When a song ends, she holds up a picture of the rocking chair. Cameron can request that the activity be repeated by swinging his foot back and forth. This activity with Cameron is one of several designed to encourage him to communicate his needs and preferences.

The Curriculum Resource Teacher

Mrs. Monroe, who is the curriculum resource teacher for two schools, is in her first year at this school. Previously, she was an elementary education consultant for the board. She has worked as a consultant for two different boards of education and has extensive classroom experience teaching Grade 1 to Grade 4. She has the ministry Specialist Certificate in Special Education and Part 1 of the ministry course Computers in the Classroom.

She has coordinated ministry courses for Queen's, developed materials, and served on many committees, both in curriculum and other professional areas, as well as editing and revising various board curriculum documents.

She has already worked with Mr. Beckwith, the computer resource teacher, and found it a productive experience because of the combination of her curriculum and his computer

knowledge. "It is important", she said, "to establish good working relationships with staff members, because I work so closely with them."

At the begining of the year, time is spent on consultation, talking with teachers concerning children's needs and how she can play a role in meeting them. She attends both the primary and junior planning meetings and contributes to the planning of themes, and she works alongside individual children in the classroom or with small groups.

She is positive about the potential of computers in learning, and is willing to learn and to explore ideas about their use. In this school she feels secure in working with the computer because of the support of people like Mr. Beckwith, Mrs. Dudley, and the research team.

She does wonder if the software can meet the learning needs of children and suggests that grouping arrangements be chosen with these needs in mind. Children, she says, can be of great value in teaching others. A small group of children can learn how to use software, be given the responsibility of teaching others, and so develop leadership qualities.

The Computer Centre

The centre is used by groups of children throughout the day, in accordance with a schedule listing both the times for various groups to work in the centre and which adult supervisors will be present. The 10 computers form a horseshoe against the 3 walls of the room. There is a printer in the computer office (see figure 11). More than one child can sit at a computer at a time (see figure 12). Mrs. Monroe and Mr. Beckwith are working with nine students from the Grade 2/3 class. These students are learning Logo, and will later teach their peers, thus increasing their leadership skills and written organizational skills. The teachers

decided to introduce Logo on the ICON to this mixed-ability group as a way to meet these objectives.

Seated on the floor with their teachers, the students are having their first lesson on Logo. After a number of questions and a brief discussion of what Logo is, Mrs. Monroe explains, "[This is] called a turtle. And this turtle is just like this car that I borrowed from Mr. O'Malley." Reaching behind her to the table along the wall, she brings out a radio-operated car. "Let me check to see if any of you have one." Immediately, Lance asks, "Can I use it?" Mrs. Monroe answers, "No, because apparently the batteries are low at this point in time."

She explains the connection of the car to Logo, "But if I want that car to go toward Adrian, what do I have to do?" Lance is ready with an answer and says, "You have to press that button forward."

"Now the little turtle on your computer is just like this little car." Someone says, "It moves." She goes on without a pause by asking, "When you want it to move, to do something, what do you think you might be able to use?" "One of those handles", suggests Daniel. As usual, she accepts the suggestion positively, "You could, but we don't have them!" Carl suggests "the keyboard", and Mrs. Monroe gestures in Carl's direction to accept his contribution.

She then notices Lee's raised hand and foregoes what she was about to say. Lee says, "You could carry the keyboard by you if it would come apart." Mrs. Monroe responds, "You could, and you're almost right." Lance, Jeff, and Daniel have hands grasping for the ceiling. Lance says "I know."

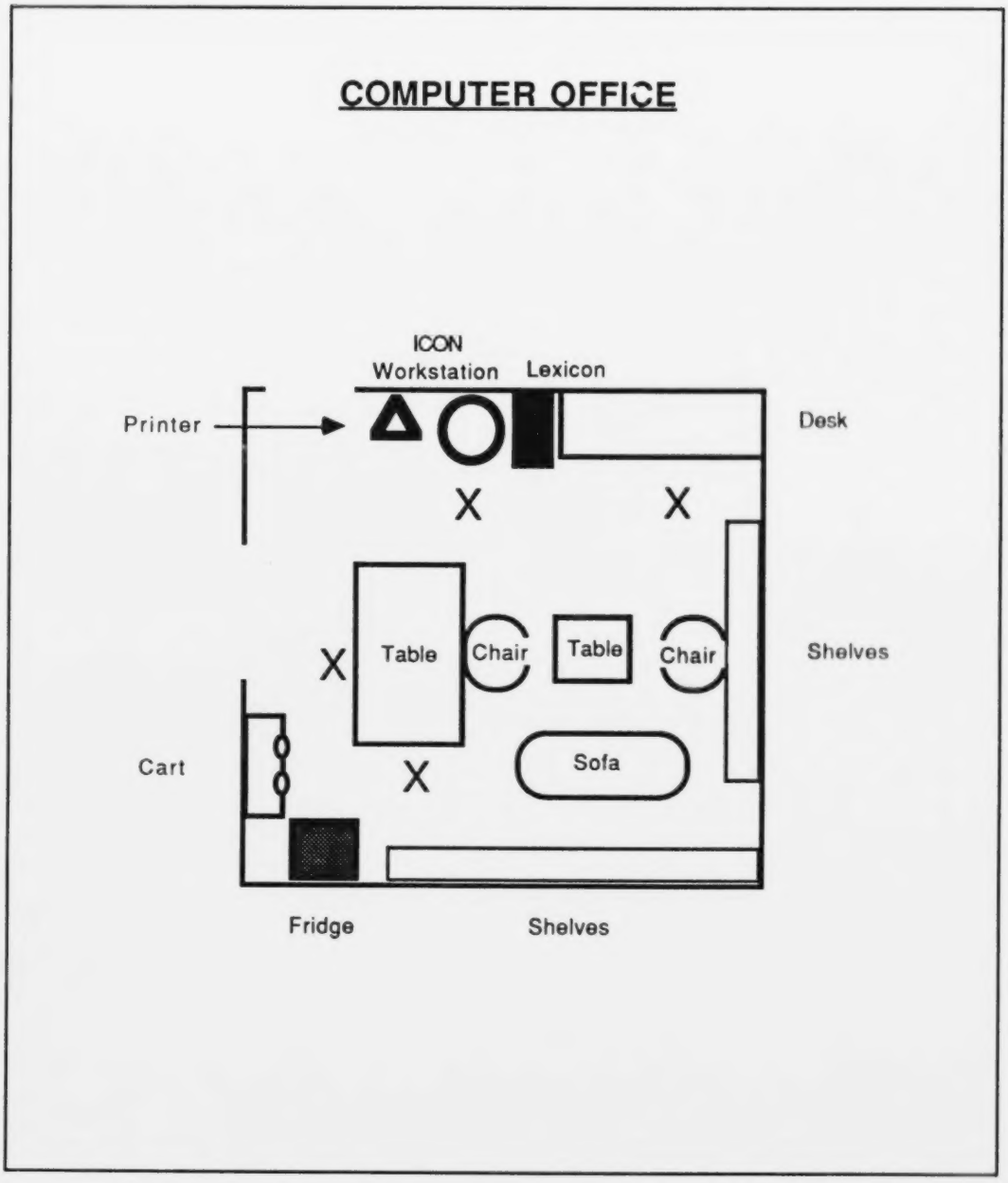

Figure 11. Computer Office

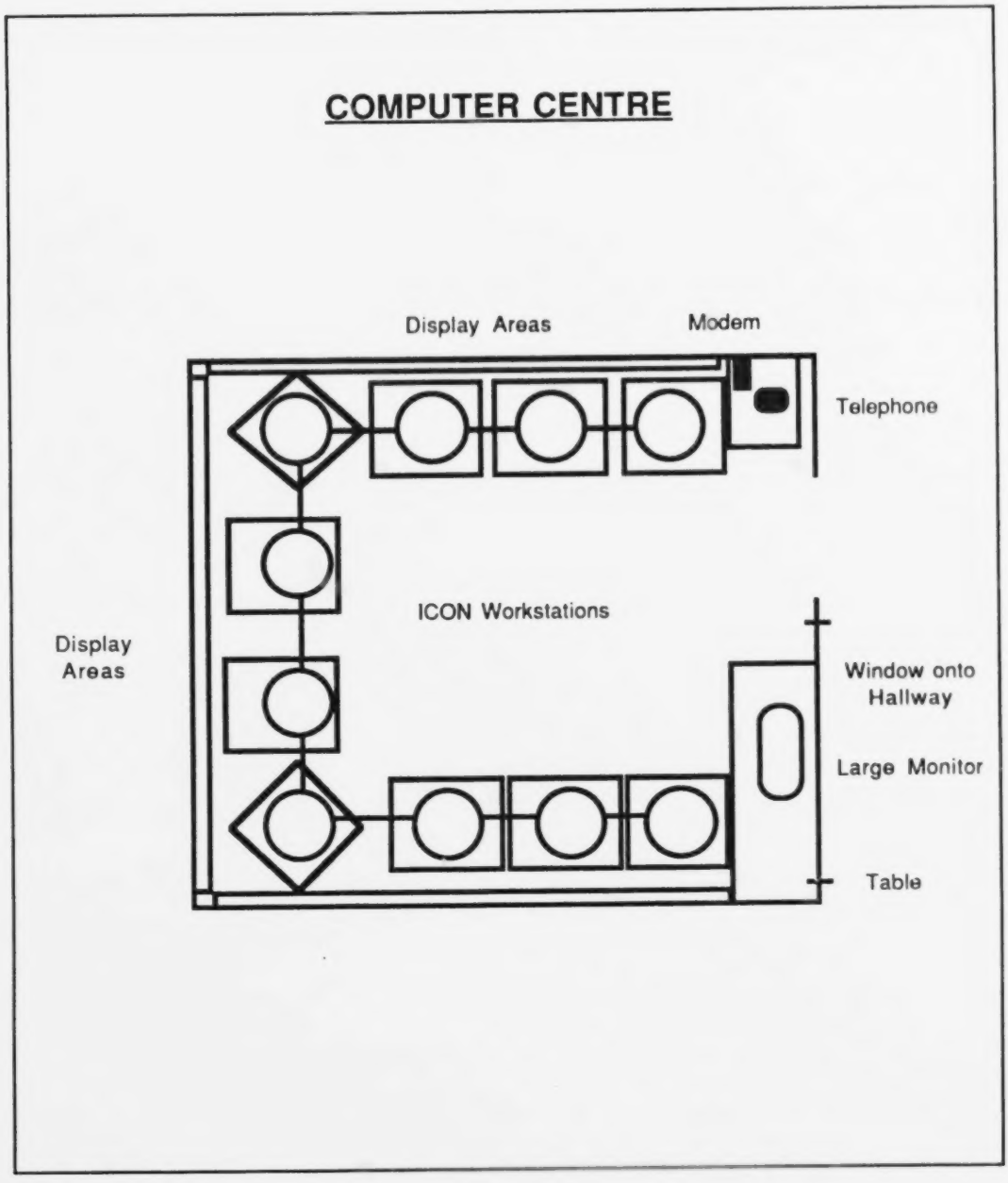

Figure 12. Computer Centre

Mrs. Monroe points to Daniel who says, "There are some buttons on the side with arrows. You press the arrow and that's where the turtle goes." Carl's and Jeff's hands go up and Carl is picked. "The trackball?" he offers with excitement in his voice. "You could. Super suggestions! All of these are possibilities." She makes a connection between the car going forward and the turtle going forward, and explains that the developers of Logo decided to use words typed into the computer as the mechanism for telling the turtle where to go. A problem is posed to the children: "How does it [the turtle] know when to stop?" She decides to show the students the procedures by having the children engage in a version of the game "Mother, May I?"

Mr. Beckwith lines the children up at the far end of the centre. All the boys are at one end. Joanna and Angie are by themselves at one end. He starts the game: "OK, now I want you to pretend that you're the turtle in the computer for a second. OK? And we're going to give you a command. Alright? Forward!"

Very slowly and almost completely in step, the children move forward and continue as though they can go through the wall. "Now, is there a problem with that?" he asks. Several children say at once, "Yes you didn't tell us to stop!"

"Right, well how am I going to tell you how far to go?" he asks the students. "Let's go back." While everyone is returning to the far wall, Jeff turns around and gives Mr. Beckwith a suggestion. "Forward, two steps." Mr. Beckwith repeats this advice, "Forward two steps. OK! Let's try this then. I want you to go forward, and when, if I give you a number as Jeff said, he said 'two steps', if I give you a number like 'two', then I want you to think of that as steps. OK?"

"So you see the difference? What we've done now? We've told it. We've told the turtle where we want it to go. Forward." Lance has, by this time, figured out everything, "So that's what you use, letters and numbers," he says. Lance is pleased. His spontaneous response implies that he has made the link between Mrs. Monroe's discussion about choices a programmer must make and the program they will use, Logo.

The French Teacher

Mrs. Fillippe, who has taught French for 20 years, has been teaching full time at this school for the past two years, while previously her time was split between two or three schools. She teaches Grades 1 through 6 and, as of this year, she teaches extended French to the junior grades.

Mrs. Fillippe has worked on a board committee trying to get French into the primary grades. She has also worked for the ministry in drawing up guidelines for teaching French from Kindergarten to Grade 13.

Her first goal is to make the children feel that they are good at what they are doing. "You have to be very careful with small children to make sure that they get to like what they do, because if they get put down, then that's the end of that". She tries to teach so that children do not make mistakes, "If they do I say, 'Excellent, but...,' and then have the whole class repeat the corrected version."

She finds there is a lot of planning involved because she teaches at six different levels. In the primary division she links up with what is being studied in the regular classes. This involves planning more activities and finding more pictures for the younger grades. Grammar

and other more difficult structures and reading material have to be integrated into her program for higher grades.

Some of the older children she finds rude, sarcastic, and disrespectful, and she sometimes feels compelled to break off the lesson in order to talk about what is proper behaviour. She tries not to appear cross or angry herself, but will tell them that she is disappointed in them by saying, "You really let me down."

Mrs. Fillippe makes extensive use of pictures, posters, tapes, and records, and has a series called Tele Francais on video tape. The Grade 3 students are using a text which comes with audio tapes and worksheets, but often she takes from texts the material she believes will be most valuable. Worksheets are used for consolidation, after the students have mastered the basic material.

"The computer is an enrichment tool," she says, "rather than a regular teaching tool." It is appropriate for the weaker students, as a drill-master. Currently available software is generally not appropriate for second language learners, and she is looking for "high interest, low vocabulary material."

Primary French Class

For the Grade 1/2 class the morning begins with a chorus of "Bonjour Mme Fillippe", followed by a teacher directed oral review of the date and different weather characteristics (see figure 13). Several students are eager to work in their notebooks and are already searching in them and a few continue to do so during the oral review of the parts of the face and head. Julian and Amy have been conducting an animated conversation while sitting together at the

back of the room. In order to capture their attention, Mme Fillippe asks, "Julian, de quelle couleur sont les yeux d'Amy?" Julian shakes his head in response. "Amy, de quelle couleur sont les yeux?", she asks. Receiving no reply she continues, "Sont oranges?" Mme Fillippe points to her eyes as she approaches their desks. "Oranges," Amy repeats. "Sont oranges?" she asks with a startled expression on her face. "Les yeux sont oranges?" Both boys are grinning and nodding. "Non, les yeux sont bruns, et les yeux de Julian sont bleus," Mme Fillippe states in a comically exasperated voice. She continues naming the colours of several other children's eyes. Julian and Amy attend to the lesson momentarily.

Mme Fillippe moves to Russ who had his hand up and says, "Russ, montre-moi les dents." He goes to the front blackboard and on the second try points to the correct part on the face picture. "Montre-moi les yeux, Devon," she continues as several others are called up to the board before the whole class joins her in a song using the vocabulary they have just reviewed.

> "La tête, les yeux, le nez. La tête, les yeux, le nez. La tête, les yeux, le nez, la bouche. Le cou, la main, le dos".

This is sung to the tune of the Farmer in the Dell, with students and teacher pointing to the appropriate parts as they sing. New vocabulary, including the parts of the hand, is then orally introduced.

The children work in their notebooks on drawings of faces and people, labelling the parts of the body and face using the new vocabulary. This labelling activity is a particular favourite of the primary grades. They are encouraged to use their imagination in their drawings.

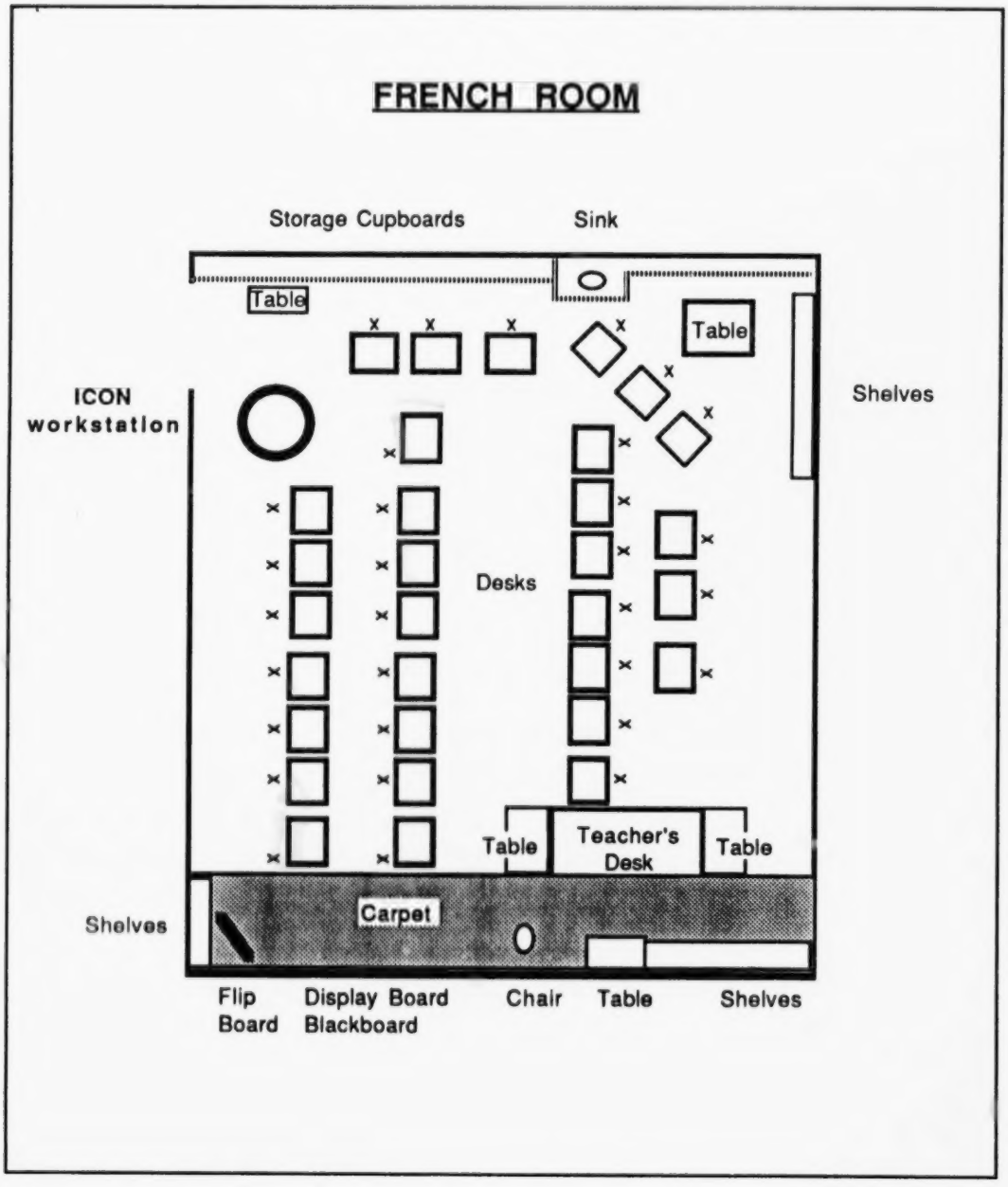

Figure 13. French Room

Junior French Class

The Grade 5 French program of extended French curriculum encompasses language development as well as a study of S.E.S. units using the French language. This lesson begins with an oral question and answer session incorporating positional terms such as avant, devant, à côté de, and derrière and proceeds to a description of the clothing of the students. Many hands are eagerly raised to contribute to this challenge. "Qu'est-ce que tu portes, Jack?" asks Mme Fillippe "Ah, les...," Jack hesitates as he begins. "Je porte," prompts Mme Fillippe "Je porte... Je porte les pantalons gris," Jack begins. "Un pantalon gris," corrects Mme Fillippe. Jack mentions a colour that is difficult to hear. "Jaune," responds Mme Fillippe. "Jaune and the....," he hesitates again pushing his desk backwards with his feet. "Qu'est-ce que c'est?", asks Mme Fillippe as she touches Jack's sweater. A variety of responses are voiced. "Qu'est-ce que c'est?", she repeats. "Chemise" is generally heard. "Une chemise?", questions Mme Fillippe with a surprised voice. Another set of replies is heard. "Chaussette?", she again questions with raised eyebrows. "Un chandail," is heard. "Merci!", she responds gratefully walking away from Jack. "Un chandail." She crosses her arms, sighing deeply, "Quelle catastrophe!" The oral discussion and questioning continues for several more minutes including the months, days of the week, and weather conditions. Most responses are made in complete sentences.

The class is then divided into social and environmental study groups to complete projects on the theme of Indians of the Plains based on topics such as customs, habits, tools, and homes. These have been previously examined in class. Some spread their posters on the floor while others circle around the desk tops. Kurt, Diana, and Randy are copying a map showing the nations of the prairie region.

A group of boys who have already finished their project are playing a French game in the rug area. On the floor in the middle of the room, Lisa and Susan are working on a poster of Les Tipis. Mme Fillippe helps Keena use an English/French dictionary to locate and spell unknown words. Amelia and Andrea are also working on the floor in the central area of the classroom. Their poster shows a variety of Indian tools and artifacts.

Some children have completed their projects and use stories and activity cards from their reading lab. The boys who were playing the French game are asked to work with the reading lab as well. Mme Fillippe circulates among the students giving guidance and assistance when required.

The Music Teacher

Mr. Jacobs, a half-time music teacher at this school, teaches at another school 1/8th time. He conducts a choral group at one of the high-schools, and also conducts three cathedral choirs. In addition he is a senior organ instructor, and teaches a second year sight singing course at Queen's University. He works with all of the teachers and students in the school, "One of the best things about this school is all the teachers see the worth of music."

He sees his role as "a person who opens doors" and education as "a process of teaching children how to learn." He hopes to impart to the students the spirit of music, "Once you convince them that it is fun and enjoyable they're going to like [it] too. We try to make it as much fun as possible. I try to instill a love of music [so] that they'll want to make music and have some competence in it too."

His teaching style is based on his mood and the mood of the children. He does blackboard work when they are quiet and calm, and they sing songs and have a good time with the music when they seem sad or depressed. He uses the children in the class as teachers, so that when one child can sing in tune he uses that child to teach the others.

He emphasizes singing and describes his program as fairly product oriented. Students read songsheets, use Orff instruments, and work with families of instruments while singing at the same time. Although he has no experience using computers as a teaching tool he is enthusiastic about the possibilities of teaching skills associated with writing music.

"I am hoping that it will help me teach notation--notation on the blackboard is very dull. It looks like the children will have a lot of fun on the computer creating and discovering what they've created on it--like the graphics they do. It seems to be more of a game on the computer, and games are a way of getting to a child--their whole life is playing games--and I hope the computer will be a means of teaching a rather difficult subject," Mr. Jacobs summarizes.

The Remedial/Enrichment Teacher

Mrs. Johnson is the remedial/enrichment teacher. She works half-time at this school and half-time in a regular Grade 2 classroom at another school. She has 25 years experience. Approximately half of this was teaching blind, learning disabled, and developmentally handicapped children. She has taken several ministry specialist courses, has worked on a board language document, and has participated in a number of workshops.

Her role, she says, is to give support, enrichment, and remedial work in the school, and to work closely with the curriculum resource teacher. She is currently involved in several projects with Mrs. Monroe--they are developing research skills among junior level children, and a science enrichment unit with a group of able learners. She takes several children out of the classroom to work on reading skills and works closely with two primary children. Remedial help is given both in the classroom and on a withdrawal basis, depending on the preference of the classroom teacher.

She tries to teach students how to learn since learning is an ongoing process throughout life involving the process of learning rather than concentrating on content. She believes her role is to instill confidence and self-esteem, and she encourages students to explore on their own.

She thinks the teacher can influence learning by being approachable and non-judgemental, and by attempting to create an interesting environment containing information and activities which are relevant to the child's everyday life. Her teaching style is eclectic, and she might use a different style for each child if necessary. "If it works for a child and a child is learning, use it," she says.

She notes, "I can't separate the [different subject] areas, because I find they're all interrelated." She believes that language is fundamental to all learning, and that learning mathematics develops a different dimension of language. She seldom uses textbooks, and prefers to use hands-on materials as well as the student's own writing.

She has limited experience with computers, but with time she hopes to become familiar with both the hardware and software, so that she can help children with the new technology. She is concerned about the time young children spend on the computer instead of more active

learning activites, "There isn't any socialization when you are interacting with that machine, and at that stage children are learning to play with one another." She suggests that the computer is a more sophisticated tool than teachers or students have had access to in the past.

The Librarian

Mrs. MacDonald is a qualified teacher and librarian who works as a half-time non-teaching assistant because the board does not hire librarians. Her role is changing: in the past she worked directly with teachers, but now much of what she does occurs in conjunction with the curriculum resource teacher, "I'm here to do whatever the teachers and children want me to do," she says.

Mrs. MacDonald believes reading should be an enjoyable experience and that she can play an important part in this goal. "I see my role as part of a force that makes them want to learn to read," she comments.

Although she sees each class twice a week, once for story time or research time and once for book exchange, she is attempting to institute an open-door policy and more flexible scheduling with a sign-up roster.

Mrs. MacDonald is not in the school on the night of the weekly in-service, and because of this absence she was feeling "very much in the dark". In late January she acquired a computer in the resource centre, and is enthusiastic about learning how to incorporate it into the children's library research experience.

The Principal

Mr. Williams has been principal at this school since September, 1985. While Mr. Williams and his vice-principal have responsibility for this and another school, he spends most of his time at this school and the vice-principal handles most of the administrative duties at the other school. He has been a principal for 18 years and has a total of 26 years of experience in education. He is very active in the teachers' federation, having held most of the offices at the local level as well as the office of President of the Ontario Public School Teachers' Federation.

Mr. Williams is committed to resource-based learning, which he believes provides "opportunities for students to learn through choices with varied resources readily available to them within and outside the school." In every school he has been associated with, he has worked towards changing the library from a "book depository" to a resource centre which becomes a focal point for resource-based learning with unscheduled access and the human resources to service it. Mr. Williams suggests that he wants to change how children are taught in the classroom, to move towards independence in learning and increased creativity, "I do not like the word freedom, but giving students the opportunity to do more on their own under teacher guidance... the teacher becomes a facilitator of learning."

Mr. Williams thinks the computer centre should be part of the resource-based approach. Meanwhile the computer could help the school to become more resource-based because its use will encourage the teachers to program for individuals.

Mr. Williams views the ICON as "a Cadillac, where maybe a Volkswagen would be enough." He is concerned about the software shortage, especially in the area of social and environmental studies, and about the lack of Canadian materials. The staff, he says, see the

currently available material as an add-on to the curriculum, rather than as an integral part of the existing curriculum.

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